8982

# CONTENTS

## No. 1, May, 1934

[Issued August 29, 1934.]

Page.

HASSELMANN, C. M. Retothel-sarcoma among Filipinos in the Tropics ........ 1
Three plates.

YUTUC, LOPE M. Experimental studies on the curative treatment of surra in native horses in the Philippines, I ........ 9

RANDALL, RAYMOND. Studies in surra, II: Pseudoreactions in complement-fixation tests for trypanosomiasis ........ 29

RUSSELL, PAUL F. Malaria and anopheles reconnaissance in the Philippines, II ........ 43
One plate.

HERMANO, A. J., and GAVINO SEPULVEDA, Jr. The vitamin content of Philippine foods, III: Vitamin B in various fruits and vegetables ........ 61
One plate.

TANCHICO, SIMEONA SANTIAGO, AUGUSTUS P. WEST, and J. FONTANOZA. Philippine panao (Dipterocarp) resin ........ 75
Three plates.

ADRIANO, F. T., S. B. OLIVEROS, and L. G. MIRANDA. The Lane-Eynon volumetric method for the determination of lactose in milk 83

MICKEL, CLARENCE E. Mutillidæ of the Philippine Islands ........ 91
One plate.

## No. 2, June, 1934

[Issued September 4, 1934.]

ZINGG, ROBERT M. American plants in Philippine ethnobotany ........ 221

HERRE, ALBERT W., and GUILLERMO L. ABLAN. Aplocheilus luzonensis, a new Philippine cyprinodont ........ 275
One plate.

HELLER, K. M. New and little-known Philippine Coleoptera ........ 279
One plate and four text figures.

ALEXANDER, CHARLES P. New or little-known Tipulidæ from eastern Asia (Diptera), XIX ........ 3
Three plates.

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yry

## No. 3, July, 1934

[Issued September 28, 1934.]

Page.

MONSERRAT, CARLOS. Does chaulmoogra treatment influence the shifting of serologic findings in lepers as obtained by the Wassermann, Kahn, and Vernes reactions? ........ 343

Six text figures.

UMALI, AGUSTIN F. The fishery industries of southwestern Samar ........ 365

Seven plates and eight text figures.

ROXAS, HILARIO A. A review of Philippine Mugilidæ ........ 393

Two plates.

ALEXANDER, CHARLES P. New or little-known Tipulidæ from eastern Asia (Diptera) XX ........ 433

Two plates.

## No. 4, August, 1934

[Issued October 31, 1934.]

TUBANGUI, MARCOS A., MARIANO BASACA, and ANTONIO M. PASCO. Hexylresorcinol as an anthelmintic: Its efficiency against the intestinal parasites of man ........ 473

RUSSELL, PAUL F. Avian malaria studies, IX: Atabrine as a prophylactic drug in sporozoite infections of avian malaria ........ 483

DE LEON, W., P. I. DE JESUS, and J. M. RAMOS. Weights of visceral organs of Filipinos in different diseases ........ 495

FAJARDO, T. G., and G. C. BELLOSILLO. A mite disease of tomato, tobacco, potato, and other plants in the Philippines ........ 523

Eight plates.

VILLADOLID, DEOGRACIAS V. Kanduli fisheries of Laguna de Bay, Philippine Islands. Remedial and regulatory measures for their rehabilitation ........ 545

JULIANO, JOSÉ B. Origin of embryos in the strawberry mango ........ 553

Three plates.

ERRATA ........ 563

INDEX ........ 565

THE PHILIPPINE
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VOL. 54 MAY, 1934 No. 1

# RETOTHEL-SARCOMA AMONG FILIPINOS IN THE TROPICS[1]

By C. M. HASSELMANN

*Practicing physician and surgeon, and head, Section on Dermatology and Syphilology, Saint Luke's Hospital Dispensaries, Manila*

THREE PLATES

The frequency of lymphatic tumors of the neck in the Tropics is well known. Recently Mueller has stressed this point and discussed in detail a number of these cases from the Dutch East Indies, where the pathology was of such different nature that it could be classified neither as lympho-sarcoma nor as lympho-epithelioma. He thinks that chewing of betel nuts, the custom of filing the teeth, the common occurrence of pyorrhœa and tooth infections, and other irritations are responsible as etiologic factors for these not uncommon nontuberculous tumors.

The proper classification of these tumors arising primarily in lymphoid tissues, however, often presents great difficulties. The reports on this subject by Ghon and Roman, Foot, Connor, Oberling, Richter, Roulet, and others show all the divergence of opinion and nomenclature existing heretofore. Liborio Gomez, head of the Department of Pathology, University of the Philippines, and myself have always hesitated in past years to include these "mixed tumors" in any of the usual textbook nomenclature. Our confusion was dissipated after reading Roulet's publication and his convincing proposal to classify this kind of tumor as "Retothel-Sarcoma" (Roessle) on account of its origin from reticular stellate cells.

The site of these lymphatic tumors is most frequently the neck, though mediastinal as well as mesenteric lymph nodes may

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[1] This paper was read by request before the Manila Medical Society February 13, 1934.

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be primarily and only affected, or become involved, too. Connor has reported a number of cases with this form of tumor as a solitary tumor in bones. The tumors are distinct from lymphosarcoma and lympho-epithelioma, not only in regard to their histological architecture but also biologically. They are less actively growing lesions with relatively slow development, and less expansive and tissue-destroying tendency. Metastasis occurs, but metastatic dissemination is not a tendency. Furthermore, as Lalung-Bonnaire and Bablet have pointed out, the tumors seem to be rather radio-resistant, contrary to the ordinary lymphatic new growths originating either from the follicular lymph cells or from the endothelial linings of the lymph sinus.

Arising primarily in lymphoid tissue, the tumor is composed neither of lymphocytes or their immediate precursors nor of endothelial cells. The histologic study bears out that it has no connection with ordinary vascular or sinus endothelium and is, therefore, not an "endothelioma." Its cells, furthermore, do not resemble any lymphocytes or their formative cells, and is, therefore, not a "lympho-sarcoma." The tumor, however, is derived from the stellate cells of the reticulum. In the silver-impregnation method, after Foot, a strongly marked increase in the amount of intracellular reticulum fibers becomes demonstrable.

The tumor is softer than the ordinary malignant growth; its consistency depends on the amount of reticulum fibers formed by the tumor cells. Though the connective tissue septa between the lobules of the lymph node may have been destroyed, the tissue-destroying tendency and expansiveness of the tumor are not pronounced. The capsule of the lymphatic glands is ordinarily intact, and the different lymph nodes remain well separated and discrete for a long time.

The usual architecture of the lymph node is lost early with regard to the normal distinction between follicular and medullary areas. Whereas in some parts the germinal centers with typical lymphoid cells may remain preserved, other areas are overrun more or less uniformly with tumor cells with but few lymphocytes left. In such places collections of lymphocytes may be seen only in the capillaries.

In some places round or oval areas of necrosis with round borders are pronounced; in other sections necrosis may be enirely absent, but considerable fibrosis is encountered instead.

The tumor cells are round, oval, or elongate, and several times arge as lymphocytes. The cytoplasm is moderate in amount, and slightly pink stained with hæmatoxylin eosin. Protoplasmic processes are quite conspicuous, and the formation of a lacy network by anastomosing cytoplasmic tendrils is pronounced. The nuclei are large and oval, with definite membranes. They contain scattered, densely staining, chromatin material with sometimes several prominent nucleoli. However, a nucleolus is not always distinguishable. Mitoses are numerous and occasionally the centrosome with astral rays is conspicuous. Tumor giant cells are present in our cases in various numbers, and of protean appearance. They resemble neither the Sternberg type, as characteristic for Hodgkin's disease, nor the well-known Langhans's giant-cells. They resemble, however, megakaryocytes in some instances, and in others they contain one or more rather pyknotic nuclei.

The comparatively slow development and a glance at the tumor description will show how different it is from the usual lympho-sarcoma and lympho-epithelioma, respectively, in regard to the histologic architecture. Naturally, the question arises as to the origin and relationship of these reticulum stellate cells, making up these retothel-sarcomata. According to Aschoff, Downey, Maximow, and others, the primitive mesenchyme cell of early embryonic life is the mother cell for all of the four types of ripe cells composing a lymph node; namely, the different white blood cells, the endothelial cells, the reticular stellate cells, and the ordinary connective tissue cells and fibroblasts. Cytologic study and differing characteristics in function suggest that a strict differentiation must be made between the endothelial cell of the linings of capillaries and lymph sinus, and the reticulum cell. Nowhere in these tumors exists any conversion or transformation from one cell type into another. The endothelium linings are all intact, though tumor cells are frequently met with just outside of the lymph sinus.

Since Richter, Roulet, and others have discussed the possibility of retothel-sarcoma developing on the basis of existing chronic lymphatic leukemia, as reported in some cases, it may be likewise stressed that no transformation of lymphocytes into tumor cells is anywhere found in our cases. This lack is worth while mentioning for the further reason that lymphoid reactions and lymphatic leukemia, which itself may be considered a tumor condition, are not uncommon in the Tropics, as pointed out by Hasselmann.

Though the clinical course of the tumor conditions is rather similar, the histology and the absence of a typical porphyry spleen require, nevertheless, differentiation from Hodgkin's disease. Retothel-sarcoma does not show the mostly dominating feature of eosinophiles, Sternberg's giant cells, the dominance of young fibroblasts, and the characteristic indented areas of necrosis in the lymph nodes, which are all quite typical for Hodgkin's granuloma. The histologic picture of retothel-sarcoma gives rather the impression of a grotesque and bizarre variety, whereas the cell structure of Hodgkin's granuloma is rather monotonous. The differential diagnosis between the two may, however, be not easy if only the histopathology of a lymph node is consulted.

The clinical course of these cases is said to be less progressive than in ordinary malignancy. Though it is claimed that the condition could be controlled by repeated surgical removal of affected lymph glands combined with radium or Roentgen therapy, the tumor condition mostly recurs and eventuates in death. All of our four cases were fatal; clinically they did not show anything in particular to warrant a detailed report. We wish, however, to add that we have also observed here in the Tropics and among Filipinos typical "lympho-sarcoma" as well as "lympho-endothelioma."

After verifying our observation of four cases as identical with Roulet's "Rethotel-Sarcoma," Dr. Antonio Gabriel has collected six more cases among Filipinos.

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# ILLUSTRATIONS

## PLATE 1

FIG. 1. Retothel-sarcoma of neck lymph node. Loose lacy network of tumor cells; marked fibrosis.

2. Typical nestlike appearance of lympho-epithelioma in a Filipino.

## PLATE 2

FIG. 1. Typical lymphosarcoma in a Filipino. Note the uniform, rather monotonous architecture consisting of lymphocytes and their immediate precursors, all of uniform appearance.

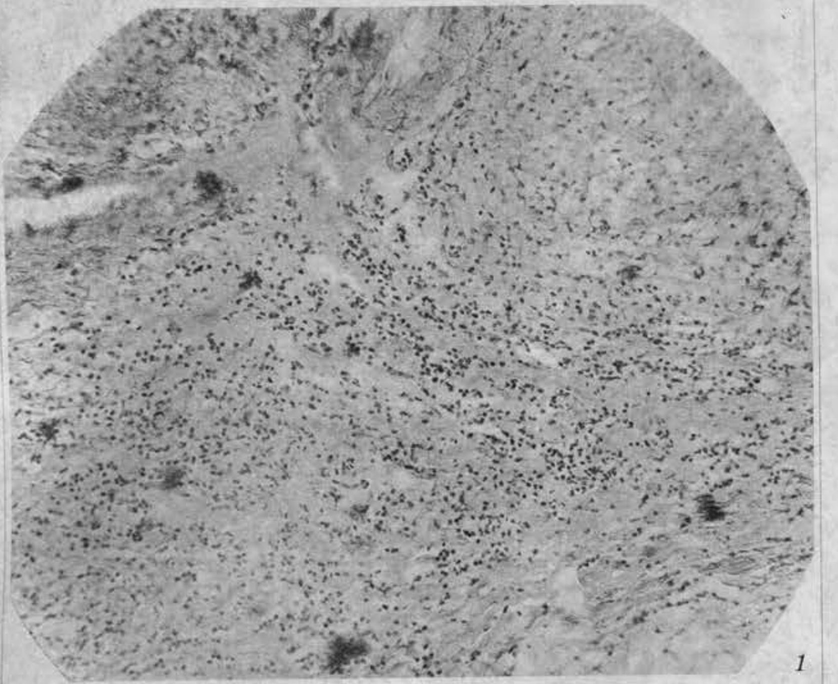
2. Retothel-sarcoma. Silver impregnation after Foot. Intracellular fibrils forming an anastomosing network.

3. Retothel-sarcoma of neck lymph node. Note the giant-cells of protean appearance; some with several pyknotic nuclei; others resembling more megakaryocytes.

## PLATE 3

FIG. 1. Retothel-sarcoma of neck lymph gland. Large oval tumor cells with conspicuous protoplasmatic processes are forming a lacy network with anastomosing tendrils. The large nuclei contain scattered, densely staining, chromatin material, and sometimes several nucleoli are distinguishable. Mitoses are numerous; one showing the typical astral arrangement is present in the center of the photograph. Note the grotesque variety of cell architecture in this form of tumor.

2. Retothel-sarcoma of mesenteric lymph gland. Section from periphery shows a zone where there are still numerous typical lymphocytes present besides the large reticulum cells of the tumor.



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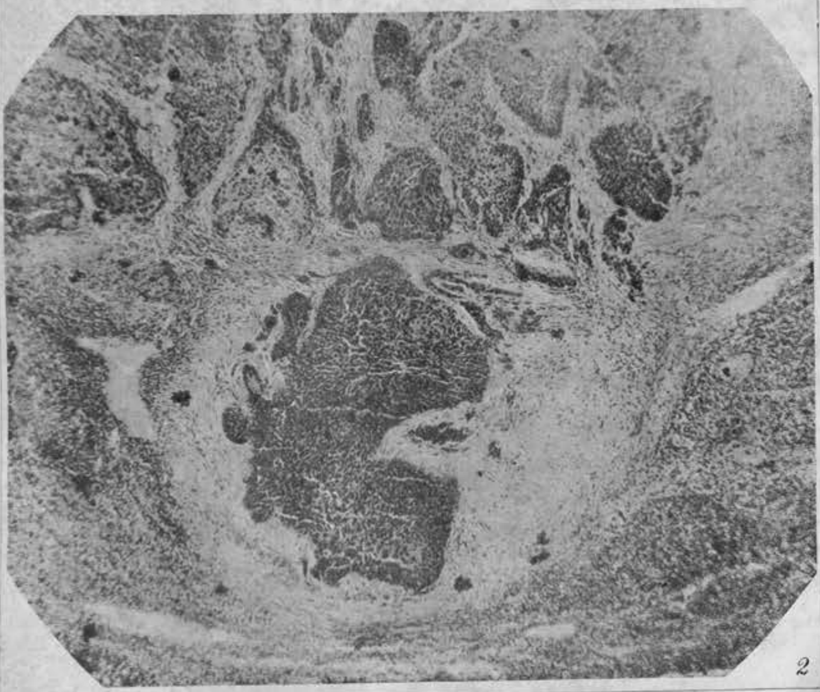

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PLATE 1.

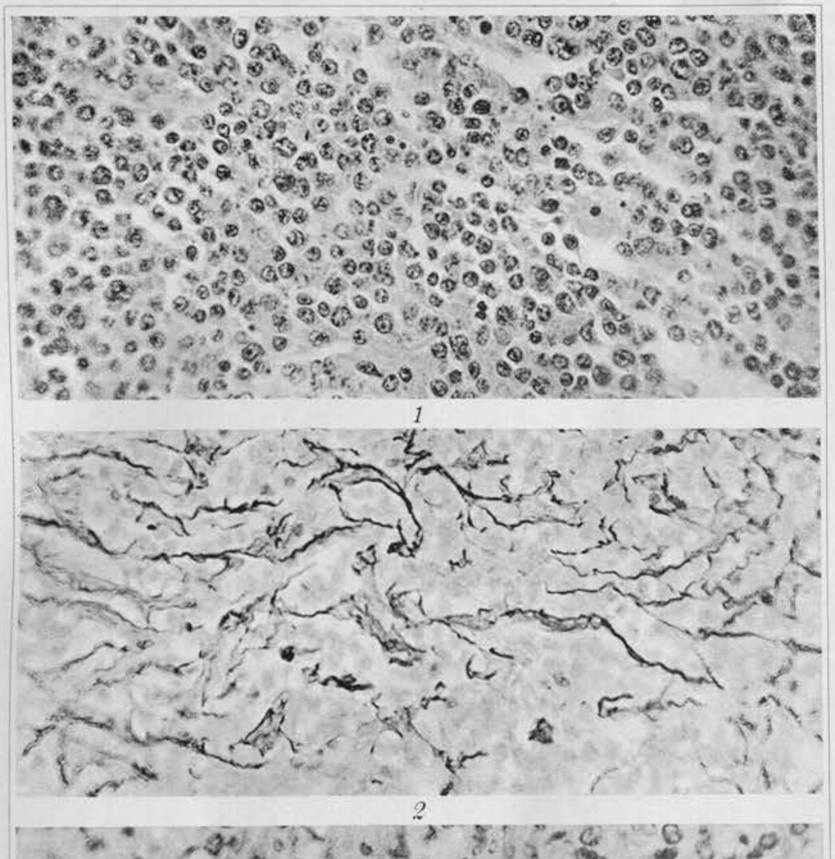
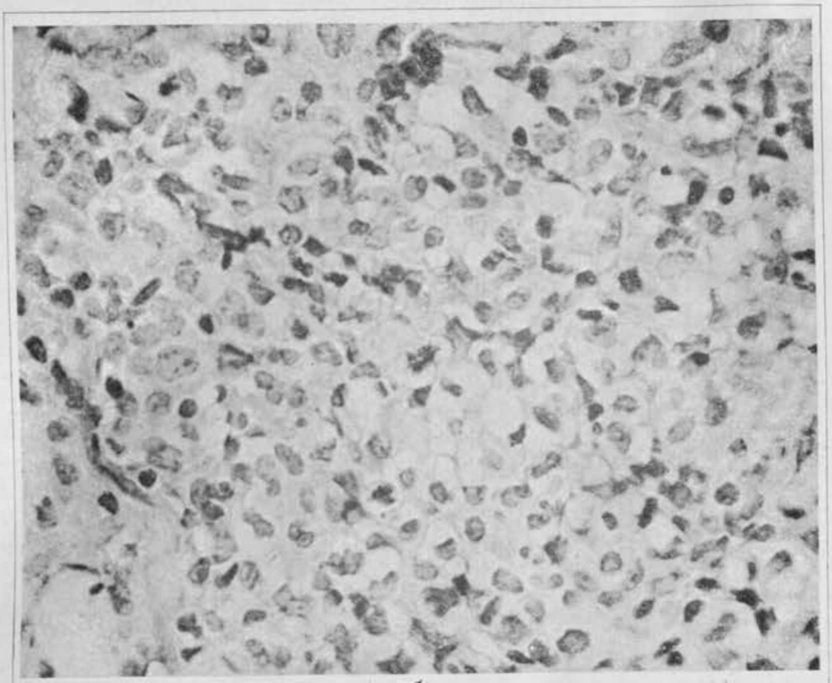


PLATE 2.



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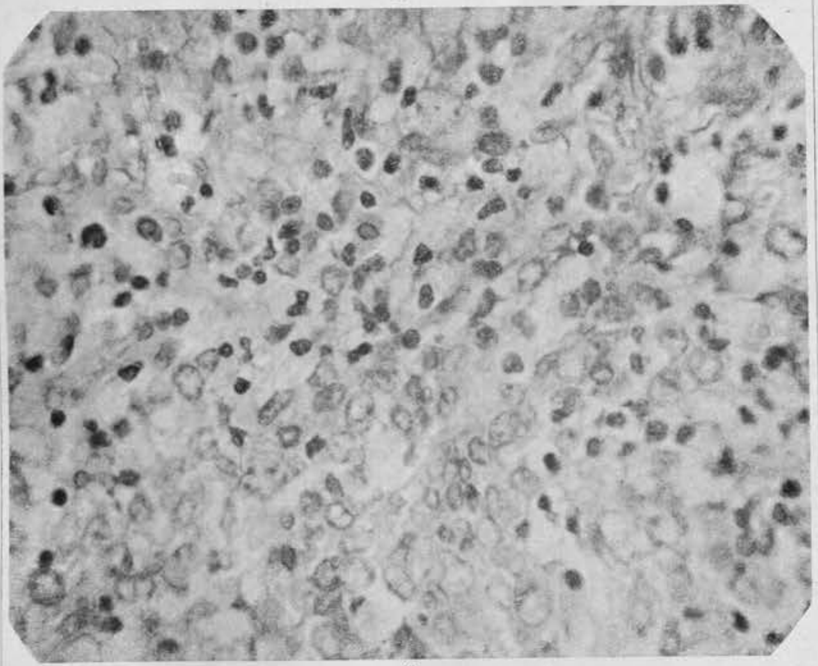

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PLATE 3.

# EXPERIMENTAL STUDIES ON THE CURATIVE TREATMENT OF SURRA IN NATIVE HORSES IN THE PHILIPPINES, I

By LOPE M. YUTUC

*Of the College of Veterinary Science, University of the Philippines, Manila*

More than half a century has elapsed since Griffith Evans (1880) discovered the causative agent of surra, *Trypanosoma evansi,* but in spite of about thirty-four years of intensive investigation into its chemotherapy, the precise method of curative treatment of the disease in horses has not gone far beyond experimentation. Whether an effective method of control of surra infection by means of a single drug, in the sense that quinine is used to control malaria, will eventually be discovered, is problematical. However, with the advent of naganol in the chemotherapy of the trypanosomiases, a more-decided advance in its treatment has been attained. To Baermann (1922) belongs the credit of being the first to use the drug against surra in horses. The literature discloses the fact that naganol has been employed as a curative remedy against equine surra either alone or in combination with other trypanocides.

Among the ardent adherents of the single-drug treatment during the last decade were Edwards (1926), Jacotot (1931), Williams (1931–1932), and Sen (1933), who employed naganol alone against surra in equines with satisfactory results. Moreover, Edwards has advocated the intrathecal injection in conjunction with the intravenous administration of the drug in order to control cerebrospinal along with circulatory infection, although Sen considers it not superior to the intravenous administration alone, especially so in early cases. On the other hand, the most-striking results obtained by the combined therapy are recorded in the experiments and observations of Bubberman, Douwes, and van Bergen (1925), Howard (1926), Kahan Singh (1927–1928), Zijp (1929), Bubberman (1930), Nieschulz (1931), and Bakker (1925, 32), who used naganol in combination with tartar emetic or atoxyl, or with other arsenic derivatives, against equine surra. Similar findings with the use of trypanocides other than naganol, supporting the combined therapy, have been obtained by Broudin, Le Louet, and Romary (1928), Romary (1929), and Jacotot (1929) with the combined use of Fourneau 309 with either sulfarsenol or neotrepol. Promising results have also been recorded on the combination of tartar emetic with mercuric iodide and etharsanol by Tubangui (1930), and by Reynolds, Simmons, and St. John (1930), respectively. In addition, Tubangui has suggested intrathecal puncture and the use of an anthelmintic as adjuvant treatments.

In this series of experiments were tested the value of naganol and etharsanol, alone and in combination, as curative agents against surra in native horses as it occurs in the Philippines. The results here presented are too inadequate to warrant final conclusions, but the lines of treatment followed in some of the experiments may fill some place in the chemotherapy of the disease.

## MATERIALS AND METHODS

*Animals used.*—Native horses, white rats, and guinea pigs were employed in this investigation. Ten of the horses were naturally infected, and the rest were artificially inoculated with virulent surra trypanosomes. The causal organism, *Trypanosoma evansi* (Steel, 1885), used was recovered by subinoculation from a horse suffering from surra and brought for treatment to the ambulatory clinic of the College of Veterinary Science, Calamba, Laguna. The trypanosomes were kept alive and maintained under laboratory conditions by continued passing through guinea pigs at various intervals.

*Drugs used.*—Etharsanol is an arsenic derivative, prepared for the first time by C. S. Hamilton in the laboratory of Doctor Loevenhart, of the University of Wisconsin. It is also called arsenical 73 and chemically known as monosodium salt of *p*-B-hydroxy-ethylamino-phenyl arsinic acid. Two lots of the drug were used. Doctor Tatum, professor of pharmacology at the same university, furnished me the first batch (lot 4) in the form of monosodium salt, a more or less opaque white powder, odorless and tasteless, and readily soluble in water. The other lot was secured from Abbott Laboratories, Chicago. It is a free-acid preparation, a white, crystalline, odorless, and practically tasteless substance, sparingly soluble in water but readily dissolved in sodium hydroxide solution. The arsenic content of etharsanol is 20.32 per cent (Stratman-Thomas and Loevenhart, 1928).

Bayer 205, or naganol, as it has been termed in veterinary medicine, is chemically a carbamide from meta-amino-benzoyl-meta-amino-para-methyl-benzoyl-1-naphthylamine-4,6,8-trisulphonic-acid.[1] The preparation intended for human use is known as germanin. Naganol is manufactured by Leverkusen Works, Germany, whence the samples used in this experiment were obtained. This nonmetalliferous drug is free from arsenic, antimony, mercury, or bismuth compounds. Germanin is a white, fine, flaky, odorless powder, and to differentiate it from the preparation intended for animal use, the latter is colored pink. It is readily soluble in water, of a slightly bitter taste, and neutral in reaction.

*Procedure employed.*—Both naganol and etharsanol were weighed carefully in a sensitive balance and prepared freshly in 10 per cent sterile aqueous solution immediately before administration. All the injections given the animals in these experiments were administered intravenously. Some of the horses artificially infected were not treated until the disease was fairly well established.

The horses infected artificially were weighed in a pit-stock scale just before treatment. The weights of the field cases were approximately determined. The horses were kept in a screened isolation ward and not released until there was no more danger of relapse. Microscopic examination of the blood obtained from the ear vein was made daily from the time of infection to about four months, and then at irregular intervals for a variable length of time. Since the naturally infected animals were distributed in the different towns of Laguna Province, precautionary measures, such as isolation, were not properly carried out. The microscopic examination of the blood of these cases was made at irregular intervals, at most once a week. Blood inoculations to susceptible laboratory animals were also made.

Intrathecal puncture of the horses artificially infected was performed with the main object of determining the presence of trypanosomes in the cerebrospinal fluid. The technic consisted briefly in securing the animal in a recumbent position after the mane at the occipitoatlantal articulation had been clipped close and disinfected with tincture of iodine. The head was then secured firmly by an assistant in a flexed position in such a manner as to expose the region. A sterile gauge 17 needle, 9 cm long, was inserted slowly through the tissues beneath and directed obliquely backward and downward with the wing of the atlas as a guide. As soon as the meninges were punctured, a clear fluid dribbled out in a stream. In some instances, to prevent the cerebrospinal fluid from being contaminated with the trypanosomes in the blood at the time of the operation; about 4 to 5 cc was allowed to flow before collecting the fluid in sterile containers. The fluid collected was injected immediately into normal white rats. For the detailed description of the procedure the original paper of Edwards should be consulted.

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[1] From the pamphlet inclosed with the drug.

## EXPERIMENTS AND RESULTS

### TREATMENT OF EXPERIMENTAL SURRA IN HORSES WITH ETHARSANOL

*Experiment 1.*—Each horse was infected subcutaneously with surra trypanosomes. Blood smears were taken daily for microscopic examination. On the fifth to the eighth day after inoculation, the trypanosomes appeared in the peripheral circulation. Soon after the surra organisms disappeared or could scarcely be determined in the blood by microscopic examination, the animal was subjected to intrathecal puncture. In some of the animals this operation was postponed until after the second paroxysm of the organisms in the peripheral circulation had occurred. The cerebrospinal fluid amounting to no less than 15 cc was subsequently collected and immediately injected intraperitoneally to two white rats, each receiving approximately one-half of the fluid obtained. Moreover, after the treatment the intrathecal operation was also repeated at variable periods to determine whether or not the trypanosomes in the cerebrospinal fluid at the time of the treatment had been killed by the action of the drug given intravenously.

The weight of the animal having been determined just before treatment, and the dose of the drug in the horse being 20 milligrams per kilogram of live body weight, the total weight of the drug to be used can be accurately estimated by simple arithmetical calculation. This amount was weighed carefully in a sensitive balance and then dissolved in enough sterile water to make a 10 per cent solution. In case of the free-acid etharsanol, the drug after weighing was placed in a sterile 50-cc beaker, and an appropriate amount of sterile water added, so that when the 10 per cent sodium hydroxide solution was added, a little at a time, to dissolve the free-acid etharsanol, the whole solution would be in 10 per cent concentration and at the same time neutral to litmus paper.

After the preliminary aseptic precautions were taken, the preparation was injected slowly into the jugular vein. On the fourth and on the eighth day the injections were repeated, following the same procedure.

In the meantime the tail blood of the rats injected with the cerebrospinal fluid was also microscopically examined daily to determine the presence of the trypanosome in the injected material. When they remained negative for twenty-five days, their susceptibility was tested by inoculation with virulent surra blood, after which they invariably succumbed to the injection.

It should be noted that the horses used in this experiment were kept in a fly-proof inclosure from the day they were infected until they were about to be killed as a result of the relapses or were safe from future relapses and cured of the disease. Due to the limited capacity of the inclosure where the experimental animals were kept, they were infected, treated, and observed at different times. The results of this experiment are presented in Table 1.

### TREATMENT OF EXPERIMENTAL EQUINE SURRA WITH NAGANOL

*Experiment 2.*—The procedure employed above was closely observed in this experiment, with the exception of the dosage of the drug and the interval of administration. Moreover, in dissolving naganol enough distilled water was placed first in the sterile container to make the 10 per cent solution, and then the drug sprinkled on top of it. No stirring was necessary to turn it into solution.

The dose was 20 milligrams per kilogram of live body weight, but this amount had to be given in broken dosage. The first dose was one-half of the total dose, the second and the third doses were one-fourth each. All these doses were administered intravenously within two weeks. All of the animals employed showed naganol intoxication in the form of periproctitis and sometimes œdema of the pendant portions of the body, which of course disappeared later. Curious rings in the hoof were also observed in the majority of the animals treated. In one case I tried giving the total dose at one time, with the consequent more-marked symptoms of naganol poisoning. The animal lost its appetite entirely for four days after the injection. Dermatitis with

TABLE 1.—*Showing the results obtained in the treatment of experimental surra in native horses with etharsanol.*

| Horse No.— | Height. | Age. | Date infected. | Period of incubation. | Weight of animal before treatment. | Presence of trypanosomes in the cerebrospinal fluid. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Before treatment. | | | After treatment. | | |
| | | | | | | Date of intrathecal puncture. | Fluid obtained. | Result of animal inoculation. | Date of intrathecal puncture. | Fluid obtained. | Result of animal inoculation. |
| | *cm.* | *Yrs.* | | *Days.* | *kg.* | | *cc.* | | | *cc.* | |
| 40 | 109 | 4 | June 24, 1932 | 7 | 100 | July 15, 1932 (15) [a] | 15 | — | | | |
| 41 | 106.5 | 2 | July 8, 1932 | 5 | 105 | July 25, 1932 (13) [a] | 20 | — | | | |
| 45 | 106.5 | 3 | Aug. 3, 1932 | 7 | 130 | Aug. 22, 1932 (13) [a] | 15 | + | Aug. 31, 1932 (2) [b] | 4 | + |
| 47 | 110 | 5 | Aug. 29, 1932 | 5 | 140 | Sept. 8, 1932 (6) [a] | 8 | — | Sept. 16, 1932 (1) [b] | 15 | — |
| 48 | 99 | 2 | Sept. 10, 1932 | 6 | 94 | Sept. 30, 1932 (15) [a] | 15 | + | Oct. 15, 1932 (8) [b] | 15 | + |
| 52 | 106 | 3 | Oct. 24, 1932 | 6 | 115 | Nov. 4, 1932 (6) [a] | 15 | — | Nov. 16, 1932 (5) [b] | 15 | — |
| 62 | 116 | 2 | Aug. 20, 1933 | 7 | 118 | Sept. 10, 1933 (15) [a] | 24 | — | Sept. 24, 1933 (7) [b] | 20 | + |

| Horse No.— | Height. | Age. | Date of treatment. | Amount of drug used. | | Results. |
|---|---|---|---|---|---|---|
| | | | | Salt. | Acid. | |
| | cm. | Yrs. | | g. | g. | |
| 40 | 109 | 4 | July 15, 1932 | 2 | | Relapsed July 24, 1932. Killed five days later for anatomy specimen. |
| | | | July 18, 1932 | 2 | | |
| | | | July 22, 1932 | 2 | | |
| 41 | 106.5 | 2 | Aug. 1, 1932 | 2.1 | | Died before treatment completed, probably due to etharsanol poisoning. |
| | | | Aug. 4, 1932 | 2.1 | | |
| 45 | 106.5 | 3 | Aug. 22, 1932 | 2.6 | | Relapsed September 1, 1932. Killed fifteen days later. |
| | | | Aug. 25, 1932 | 2.6 | | |
| | | | Aug. 29, 1932 | 2.6 | | |
| 47 | 110 | 5 | Sept. 8, 1932 | | 2.8 | No relapse up to the present writing (December 20, 1933); animal in excellent condition. Animal inoculation negative (blood). |
| | | | Sept. 11, 1932 | | 2.8 | |
| | | | Sept. 15, 1932 | | 2.8 | |
| 48 | 99 | 2 | Sept. 30, 1932 | | 1.88 | Relapsed October 18, 1932. Killed October 25, 1932. |
| | | | Oct. 3, 1932 | | 1.88 | |
| | | | Oct. 7, 1932 | | 1.88 | |
| 52 | 106 | 3 | Nov. 4, 1932 | | 2.3 | No relapse. Due to sub-luxation of the coxo-femoral articulation, killed July 27, 1933. Animal inoculation negative (blood). |
| | | | Nov. 7, 1932 | | 2.3 | |
| | | | Nov. 11, 1932 | | 2.3 | |
| 62 | 116 | 2 | Sept. 10, 1933 | | 2.36 | Relapsed September 25, 1933. Killed three days later. |
| | | | Sept. 13, 1933 | | 2.36 | |
| | | | Sept. 17, 1933 | | 2.36 | |

[a] Days after first appearance of trypanosomes in the peripheral circulation.

[b] Days after last injection.

tenderness of the skin and falling of hair were also observed. The face became swollen and paraphimosis occurred which lasted for some time. The results of this experiment are presented in Table 2.

### THE TREATMENT OF EXPERIMENTAL SURRA IN EQUINES WITH SIMULTANEOUS INJECTIONS OF ETHARSANOL AND NAGANOL

*Experiment 3.*—The technic used was essentially the same as that in the two foregoing experiments. The drugs, having been calculated, weighed in a sensitive balance, and prepared in sterile aqueous solutions, were injected simultaneously into each jugular vein of the horse, the etharsanol being given first and immediately followed by the naganol. The dosage of the drugs was the same as in the previous experiments, except for the free-acid etharsanol which was reduced to 15 milligrams per kilogram of live body weight, for reasons that will be discussed later in this report. All the horses used showed trypanosomes in the cerebrospinal fluid by inoculation to white rats. Naganol intoxication was noted in all the animals employed in this experiment. The individual records of the horses used are summarized in Table 3.

TABLE 2.—*Showing the results obtained in the treatment of experimental surra in native horses with naganol.*

| Horse No.— | Height. | Age. | Infected. | Period of incubation. | Weight of animal before treatment. | Presence of trypanosomes in the cerebrospinal fluid. | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Before treatment. | | |
| | | | | | | Date of intrathecal puncture. | Amount of fluid obtained. | Result of animal inoculation. |
| | *cm.* | *Yrs.* | | *Days.* | | | *cc.* | |
| 38 | 114 | 3 | Feb. 15, 1932 | 7 | 139 | Mar. 9, 1932. (17) [a] | 20 | + |
| 39 | 122 | 8 | June 16, 1932 | 7 | 175 | July 1, 1932. (9) [a] | 25 | + |
| 56 | 119 | 4 | Jan. 18, 1933 | 6 | 178 | Jan. 28, 1933. (5) [a] | 18 | + |
| 57 | 116 | 8 | Jan. 18, 1933 | 6 | 171 | Jan. 28, 1933. (5) [a] | 17 | — |
| 59 | 96.5 | 1.5 | Feb. 11, 1933 | 8 | 80 | Feb. 22, 1933. (4) [a] | 13 | — |
| 63 | 114 | 3 | Sept. 12, 1933 | 8 | 145 | Sept. 28, 1933. (9) [a] | 10 | + |
| 64 | 104 | 2.5 | Sept. 13, 1933 | 8 | 111 | Oct. 1, 1933. (11) [a] | 20 | + |

TABLE 2.—*Showing the results obtained in the treatment of experimental surra in native horses with naganol*—Continued.

| Horse No.— | Height. | Age. | Presence of trypanosomes in the cerebrospinal fluid. After treatment. Date of intrathecal puncture. | Fluid obtained. | Result of animal inoculation. | Date of treatment. | Amount of drug used. | Results. |
|---|---|---|---|---|---|---|---|---|
| | *cm.* | *Yrs.* | | *cc.* | | | *g.* | |
| 38 | 114 | 3 | July 3, 1932. (100) [b] | 20 | + | Mar. 12, 1932<br>Mar. 19, 1932<br>Mar. 25, 1932 | 1.4<br>0.7<br>0.7 | Relapsed July 6, 1932. Killed five days later. |
| 39 | 122 | 8 | ------ | ------ | ------ | July 6, 1932<br>July 12, 1932<br>July 19, 1932 | 1.75<br>0.875<br>0.875 | July 23, 1932, developed tetanus. Died four days later. |
| 56 | 119 | 4 | Mar. 29, 1933. (47) [b] | 17 | + | Jan. 28, 1933<br>Feb. 3, 1933<br>Feb. 10, 1933 | 1.78<br>0.89<br>0.89 | Relapsed March 29, 1933. Killed April 3, 1933. |
| 57 | 116 | 8 | Apr. 22, 1933. (71) [b] | 26 | — | Jan. 28, 1933<br>Feb. 3, 1933<br>Feb. 10, 1933 | 1.71<br>0.855<br>0.855 | The horse developed laminitis during the period of observation. Still alive at the present writing (December 20, 1933); animal inoculation negative (blood). |
| 59 | 96.5 | 1.5 | June 29, 1933. (114) [b] | 20 | — | Feb. 22, 1933<br>Feb. 28, 1933<br>Mar. 7, 1933 | 0.8<br>0.4<br>0.4 | Animal still alive at the present writing (December 20, 1933); condition excellent. Animal inoculation negative (blood). |
| 63 | 114 | 3 | Nov. 7, 1933. (27) [b] | 20 | + | Sept. 28, 1933<br>Oct. 4, 1933<br>Oct. 11, 1933 | 1.45<br>0.73<br>0.72 | Relapsed November 7, and died December 3, 1933. |
| 64 | 104 | 2.5 | Oct. 28, 1933. (27) [b] | 15 | + | Oct. 1, 1933 | 2.22 | Relapsed October 31, 1933. |

[a] Days after first appearance of trypanosomes in the peripheral circulation.
[b] Days after last injection.

TABLE 3.—*Showing the results obtained in the treatment of experimental surra in horses with simultaneous injections of etharsanol and naganol.*

| Horse No.— | Height. | Age. | Infected. | Period of incubation. | Weight of animal before treatment. | Presence of trypanosomes in the cerebrospinal fluid. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Before treatment. | | | After treatment. | | |
| | | | | | | Date of intrathecal puncture. | Fluid obtained. | Result of animal inoculation. | Date of intrathecal puncture. | Fluid obtained. | Result of animal inoculation. |
| | *cm.* | *Yrs.* | | *Days.* | *kg.* | | *cc.* | | | *cc.* | |
| 35 | 115.5 | 2 | Nov. 16, 1931 | 7 | 175 | Dec. 3, 1931. (11)[a] | 15 | + | Mar. 16, 1932. (91)[b] | 20 | — |
| 36 | 104 | 2 | Jan. 5, 1932 | 6 | 134 | Jan. 20, 1932. (10)[a] | 15 | + | Feb. 29, 1932. (16)[b] | 8 | — |
| 54 | 89 | 2.5 | Nov. 25, 1932 | 6 | 109 | Dec. 22, 1932. (22)[a] | 15 | + | Apr. 17, 1933. (103)[b] | 25 | — |

| Horse No.— | Height. | Age. | Date of treatment. | Treatment with— | | | Results. |
|---|---|---|---|---|---|---|---|
| | | | | Etharsanol. | | Naganol. | |
| | | | | Salt. | Acid. | | |
| | *cm.* | *Yrs.* | | *g.* | *g.* | *g.* | |
| 35 | 115.5 | 2 | Dec. 3, 1931 | 3.5 | -------- | 1.75 | No relapse. Animal still alive. Animal inoculation negative (blood). Increase in weight and in excellent condition. |
| | | | Dec. 9, 1931 | 3.5 | -------- | 0.875 | |
| | | | Dec. 16, 1931 | 3.5 | -------- | 0.875 | |
| 36 | 104 | 2 | Jan. 31, 1932 | 2.68 | -------- | 1.34 | No relapse; animal inoculation negative (blood). Increase in weight and in excellent condition at the time the horse was traded for a new animal (March 31, 1933). |
| | | | Feb. 7, 1932 | 2.68 | -------- | 0.67 | |
| | | | Feb. 13, 1932 | 2.68 | -------- | 0.67 | |
| 54 | 89 | 2.5 | Dec. 22, 1932 | -------- | 1.63 | 1.09 | No relapse. Animal still alive. Animal inoculation negative (blood). Increase in weight and in excellent condition. |
| | | | Dec. 28, 1932 | -------- | 1.63 | 0.545 | |
| | | | Jan. 4, 1933 | -------- | 1.63 | 0.545 | |

[a] Days after first appearance of trypanosomes in the peripheral circulation.

[b] Days after last injection.

### THE TREATMENT OF HORSES NATURALLY INFECTED WITH SURRA WITH SIMULTANEOUS INJECTIONS OF ETHARSANOL AND NAGANOL

*Experiment 4.*—Because of the encouraging results obtained with the simultaneous treatment of etharsanol and naganol in artificially infected horses, it was tried with the field cases of surra in native horses encountered in the ambulatory clinic conducted in the towns of Biñang, Calamba, and Santa Rosa, Laguna Province, during the academic year 1932–33. Ten horses were employed, most of them only moderately affected.

The following is a summary of the clinical manifestations observed in these animals. Slow and heavy attitude, dyspnea, and knuckling of the fetlocks of the hind legs. In some of the cases a staggering gait was noted. The conjunctival mucous membrane was pale and petichiated, and in some cases even icteric. The temperature was several degrees above normal; the appetite variable, as a rule impaired during the pyretic period and good as soon as the body temperature returned to normal. Emaciation was a constant symptom. An œdematous condition of the limbs, breast, and belly was not commonly observed. In this connection other cases with œdema as a principal symptom were observed, yet they were not surra cases. The laity generally confuses surra with such a condition, hence stories of some quacks having cured surra were often heard by the students in towns visited by the ambulatory clinic of the College of Veterinary Science. Possibly this confusion exists in other provinces of the Philippine Archipelago. In the localities where the clinical cases were encountered, the term "bayawak," a Tagalog coined word, is indiscriminately applied to this œdematous condition of the belly and to surra.

The clinical diagnosis of these cases was clinched by microscopic examination of the moist-blood preparation, as well as by animal inoculation. The weights of these animals were roughly determined, as the pit-stock scale was not available in places where these clinical cases of surra were met with. The procedure in the administration of drugs was identical with that followed in experiment 3. Moreover, as may be noted in the following table, the dosage of naganol was changed not in the total amount but in the amount of the individual doses, which seems to be more readily tolerated than those of the former method. With the fatal termination of two cases, the dose of the free-acid etharsanol was reduced to 15 milligrams per kilogram of live body weight.

All of the animals treated showed symptoms of naganol poisoning in the form of periproctitis, and in one case the appetite was impaired for about a week. As a rule, however, a day after the first treatment the appetite invariably improved until the termination of the treatment. Moreover, the owner of horses 60 and 61 reported that there were about twenty other horses that died in the locality where his horses were located. He reported that these animals presented symptoms identical with those of his horses. In view of the satisfactory results obtained with his animals, some of the owners regretted not having presented their horses for treatment. The individual records of the ten horses are presented in Table 4.

## DISCUSSION

*Treatment of experimental surra with etharsanol.*—Of the three horses (horses 40, 41, and 45) presented in Table 1, that were treated with the monosodium preparation of etharsanol, two were able to tolerate the total course of injections, but relapses were observed later. Horse 41 died, after having received the second injection, apparently due to etharsanol intoxication. The results obtained indicate that the monosodium preparation, beyond establishing a temporary sterilization of the peripheral circulation, is useless against equine surra, when administered alone. On the other hand, with the use of the free-acid preparation on the three other animals (horses 47, 52, and 62) with negative cerebrospinal fluids, horses 47 and 52 recovered from the artificial infection, while the other relapsed (horse 62). Apparently the free-acid etharsanol can control surra infection in horses to a certain extent, provided the cerebrospinal system is trypanosome free. The origin of the recurrence of the disease in the case of horse 62 may be attributed to backwashes from circulation or from tissue spaces as claimed by Yorke (1921), inasmuch as the cerebrospinal fluid is free of the organism at the time of treatment. In case the infection has already gained entrance into the subarachnoid space, the prospect of controlling the disease appears even more remote, as aptly illustrated with horse 48. As relapses in surra infection are generally believed to originate from the cerebrospinal involvement, the failure of the drug in this case may be due to failure to penetrate in trypanocidal concentration through the meninges of the brain and cord, notwithstanding the observation of Stratman-Thomas and Loevenhart (1928) to the effect that this drug readily passes into the central nervous system.

*Treatment of experimental surra with naganol.*—According to the results presented by horses 38, 56, 63, and 64 under experiment 2, naganol is valueless, as far as permanent cure is concerned, when the surra organisms have already invaded the fluid of the cerebrospinal system. However, so long as the central nervous system is negative of the trypanosomes, as in horses 57 and 59, the control of infection in experimental surra can be attained, possibly even during the early stage of natural cases. Moreover, these results are supported to a certain extent by the observations of Rodenwalt and Douwes (1922), and Bubberman, Douwes, and van Bergen, to the effect that in equine surra Bayer 205 should not be given to animals that are seriously ill, and that this agent, when used alone, is likely to effect cure only in early stage of infection. Edwards attributed this circumstance to the low diffusibility of naganol, possibly owing to the large size of the molecule with the consequent lack of power to penetrate the meninges in sufficient concentration to affect the cerebrospinal infection.

The periproctitis observed in the horses subjected to naganol treatment and to the simultaneous administration of etharsanol and naganol, may give some pathogenic organisms entrance into the body of the animal, as illustrated in the case of horse 39, which died of tetanus contracted four days after the last injection. Bubberman and others made mention of a similar observation in their studies on the use of Bayer 205 in equine surra in the Dutch East Indies.

*Observations on how long Trypanosoma evansi appeared in the cerebrospinal fluid after the first appearance in the peripheral circulation.*—As shown in Tables 1, 2, and 3, the length of time that the surra trypanosome was found in the fluid of the central nervous system after its first appearance in the peripheral circulation was variable. Of the seventeen horses subjected to the intrathecal puncture, ten animals demonstrated the presence of the surra trypanosome in the cerebrospinal fluid by subinoculation to white rats, while the remainder were negative. The average number of days after which organisms were found in the cerebrospinal fluid was 12.2 days, the minimum 5 days, and the maximum 22 days. On the other hand, among horses with negative cerebrospinal fluid the average period was 9.14 days, the minimum 4, and the maximum 15. In view of this uncertainty and variation of the length of time the cerebrospinal fluid becomes infected, and the lack of clinical manifestation, especially in the early stage of the disease, suggestive

TABLE 4.—*Showing the results obtained in the treatment of field cases of surra in native horses with simultaneous injection of etharsanol and naganol.*

| Horse No.— | Height. | Age. | Approximate weight. | Location. | Date of treatment. | Treatment with— |  |  | Duration between last injection and final observation. | Animal inoculation. |  | Condition at the time of treatment. | Final observation. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  | Etharsanol. |  | Naganol. |  | Time of treatment. | Time of final observation. |  |  |
|  |  |  |  |  |  | Salt. | Acid. |  |  |  |  |  |  |
|  | *cm.* | *Yrs.* | *kg.* |  |  | *g.* | *g.* | *g.* | *Mos. days.* |  |  |  |  |
| 42 | 127 | 6 | 200 | Calamba | July 15, 1932 | 4 | -------- | 2 | 11 3 | + | — | Fair | No relapse, condition good. Due to severe contracted tendons of the anterior limbs, the horse was killed for meat. |
|  |  |  |  |  | July 22, 1932 | 4 | -------- | 1 |  |  |  |  |  |
|  |  |  |  |  | July 28, 1932 | 4 | -------- | 1 |  |  |  |  |  |
| 43 | 129.5 | 7 | 200 | do | July 16, 1932 | 4 | -------- | 2 | 16 22 | + | — | do | No relapse; condition excellent, animal still alive. |
|  |  |  |  |  | July 22, 1932 | 4 | -------- | 1 |  |  |  |  |  |
|  |  |  |  |  | July 29, 1932 | 4 | -------- | 1 |  |  |  |  |  |
| 44 | 134.5 | 5 | 200 | do | July 29, 1932 | 4 | -------- | 2 | 16 10 | + | — | do | Do. |
|  |  |  |  |  | Aug. 5, 1932 | 4 | -------- | 1 |  |  |  |  |  |
|  |  |  |  |  | Aug. 11, 1932 | 4 | -------- | 1 |  |  |  |  |  |
| 50 | 119 | 10 | 200 | Santa Rosa | Sept. 16, 1932 | 4 | -------- | 2 | 14 21 | + | — | Poor | Do. |
|  |  |  |  |  | Sept. 23, 1932 | 4 | -------- | 1 |  |  |  |  |  |
|  |  |  |  |  | Sept. 29, 1932 | 4 | -------- | 1 |  |  |  |  |  |
| 51 | 127 | 5 | 200 | do | Sept. 29, 1932 | -------- | 4 | 2 | -------- | + | -------- | Fair | Died, probably due to drug poisoning. |
|  |  |  |  |  | Oct. 6, 1932 | -------- | 4 | 1 |  |  |  |  |  |
| 53 | 112 | 5 | 150 | do | Nov. 18, 1932 | -------- | 3 | 1.5 | -------- | + | -------- | Poor | Do. |
|  |  |  |  |  | Nov. 25, 1932 | -------- | 3 | 0.75 |  |  |  |  |  |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 | 119 | 6 | 170 | do | Feb. 9, 1933 | -------- | 2.55 | 0.68 | ---------- | + | -------- | Fair | 153 days after last injection the horse was reported dead, probably as a result of a relapse. |
| | | | | | Feb. 15, 1933 | -------- | 2.55 | 1.36 | | | | | |
| | | | | | Feb. 22, 1933 | -------- | 2.55 | 1.36 | | | | | |
| 60 | 122 | 6 | 180 | Biñang | Feb. 14, 1933 | -------- | 2.7 | 0.72 | 9 21 | + | — | Poor | No relapse; condition excellent, animal still alive. |
| | | | | | Feb. 20, 1933 | -------- | 2.7 | 1.44 | | | | | |
| | | | | | Feb. 27, 1933 | -------- | 2.7 | 1.44 | | | | | |
| 61 | 122 | 5 | 170 | do | Feb. 15, 1933 | -------- | 2.5 | 1.7 | 9 20 | + | — | Fair | Do. |
| | | | | | Feb. 21, 1933 | -------- | 2.5 | 0.85 | | | | | |
| | | | | | Feb. 28, 1933 | -------- | 2.5 | 0.85 | | | | | |
| 65 | 119 | 7 | 170 | do | Sept. 25, 1933 | -------- | 2.55 | 0.68 | ---------- | + | -------- | Poor | 62 days after last injection, the animal was reported dead, probably due to a relapse. |
| | | | | | Oct. 2, 1933 | -------- | 2.55 | 1.36 | | | | | |
| | | | | | Oct. 8, 1933 | -------- | 2.55 | 1.36 | | | | | |

of the presence of the surra trypanosome in the central nervous system, as many of the horses used did not manifest nervous derangement, but on inoculation of the cerebrospinal fluid obtained from them to white rats demonstrated the presence of surra organisms; if this finding is true in naturally infected animals, the value of either of the trypanocides investigated when used intravenously alone appears very limited. Another factor that should be considered in this connection is the difficulty of determining with accuracy the duration of natural infection in horses. Moreover, this finding may also serve to elucidate the failure of naganol in some surra cases treated and reported by various investigators who had no reason for believing that there is already nervous involvement, yet relapses were observed.

*Treatment of experimental surra with simultaneous injection of etharsanol and naganol.*—The uniform results recorded in experiment 3 illustrate beyond reasonable doubt the value of the combined administration of etharsanol and naganol against equine surra even when the surra organism is already found in the cerebrospinal fluid of the animals treated. From the length of time the peripheral circulation remained negative, both to microscopic examination and to animal blood inoculation, and the excellent condition of the animals employed, it can be stated with some degree of certainty that the horses are cured of the artificial infection. Furthermore, the negative results obtained by inoculating the cerebrospinal fluid taken from them to susceptible laboratory animals denote that even this fluid is free from surra trypanosomes. This finding may further suggest that there is a synergistic relation between the two drugs employed in the treatment, possibly responsible for the penetration of the meninges of the brain and cord in trypanocidal concentration and consequently not only bringing about circulatory but also nervous sterilization.

*Treatment of natural cases of surra in native horses with simultaneous injection of etharsanol and naganol.*—Reference to horses 42, 43, 44, 50, 60, and 61, in Table 4, may furnish further evidence in support of the value of the simultaneous injections of etharsanol and naganol as a promising treatment in natural cases of equine surra. However, in order that the treatment be effective both drugs should be given in nonlethal but slightly toxic doses. The fatal terminations in horses 51 and 53 are due to drug intoxication, as in neither case the complete set of injections was tolerated. By changing the broken doses of naganol, as may be noted in horses 58, 60, and

65, it is believed that the line of treatment under discussion will be made less toxic to the animals than it would be otherwise, but its efficacy is apparently lowered, as illustrated by horses 58 and 65, which died possibly as a result of relapses. Moreover, it may also be surmised that the monosodium salt of etharsanol is tolerated better in combination with naganol than the free-acid preparation. Again, as far as the results of this experiment go, there seems to be no material difference between the efficacy of the two combinations. Finally, in equine surra with severe nervous involvement the writer entertains little hope in the value of the treatment discussed, notwithstanding the finding in experiment 3.

## SUMMARY AND CONCLUSIONS

Experiments to determine the value of etharsanol and naganol alone and in combination in native horses affected with surra were performed.

It has been found that the monosodium preparation of etharsanol is useless against equine surra. The free-acid etharsanol to a certain degree can control artificial infection, provided the cerebrospinal fluid is free of the surra trypanosomes. On the other hand, where there is already cerebrospinal involvement, its value is very limited as far as permanent recovery is concerned.

In the use of naganol against artificially infected horses, it has been observed that so long as the fluid of the cerebrospinal system is free of the surra organism, it is safe to state that infection can be controlled permanently. However, with the involvement of the nervous system, naganol has limited value. In the four horses artificially infected and with positive cerebrospinal fluid, the drug was a complete failure.

Attempts to determine the length of time the surra trypanosome appeared in the cerebrospinal fluid after its appearance in the peripheral circulation were made on seventeen horses artificially infected with surra organisms. The results were variable. Ten of the seventeen animals were positive and the remainder negative. The average period before the fluid of the central nervous system was positive was 12.2 days, the minimum was 5 days, and the maximum 22 days. On the other hand, among horses with negative cerebrospinal fluid, the average period was 9.14 days, the minimum was 4, and the maximum 15. This finding invariably limits the value of either etharsanol and naganol as trypanocidal agents, when given alone and intravenously.

By administering both etharsanol and naganol in nonlethal but slightly toxic doses and in simultaneous injections, three experimental surra horses with positive cerebrospinal fluid and six of ten naturally infected animals were cured. Some of the results of the experiments indicate that there is a synergistic relation between the two drugs used, which is possibly responsible for the complete sterilization of the cerebrospinal fluid concurrently with the circulatory system. Lastly, the simultaneous injection of etharsanol and naganol is far superior to the use of either of the two drugs given alone and intravenously for the treatment of equine surra.

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# STUDIES IN SURRA, II

## PSEUDOREACTIONS IN COMPLEMENT-FIXATION TESTS FOR TRYPANOSOMIASIS

By Raymond Randall

*Major, Veterinary Corps, United States Army; Member, United States Army Medical Department Research Board*
*Bureau of Science, Manila*

The complement-fixation test for determining infection with *Trypanosoma evansi,* the only type of pathogenic trypanosome known to exist in the Philippine Islands, provides a means of diagnosis in those cases in which the first crisis has occurred and the trypanosomes have become so scarce in the circulation that repeated microscopic examinations of fresh blood and stained thick films are negative. Negative microscopical findings with strongly positive complement fixation have been found to occur in naturally infected horses, mules, carabaos, and cattle, as well as in laboratory-infected horses, mules, guinea pigs, and rabbits. An advantage of the complement-fixation test is that a strongly positive reaction that is biologically specific is obtained in the early stages and is continuous for the duration of the disease.

As there is considerable variation in different laboratories in the volume of reagents and kind of erythrocytes employed and in the method used in adjusting the hæmolytic system, the test should be standardized to meet local conditions, apparently a more important consideration in the Tropics, in order to avoid oversensitiveness.

False positive and suspicious reactions have been obtained in a few instances in horses and mules in the Philippine Islands that were free of trypanosomiasis. The following technic was used, which in the United States, in the experience of the writer, has given comparatively satisfactory results.

### ORIGINAL TECHNIC

Three tubes containing 2 cc of physiological sodium chloride solution were employed for each specimen. Two tubes in the front row contained 0.2 cc and 0.1 cc of serum, respectively, and the serum control tube in the rear row contained 0.2 cc of the particular serum. The horse serums were inactivated in the water bath at 58° C. for thirty minutes and the mule serums at 62° C. for thirty-five minutes. The hæmolytic system consisted of 1 cc of a 3 per cent suspension of washed sheep cells, one and one-half units of pooled guinea-pig complement and one and one-half units of antisheep hæmolysin, each diluted to 1 cc with physiological sodium chloride solution. The unit of hæmolysin was determined by titration with 1 cc of a 5 per cent pooled guinea-pig complement, the complement unit by titrating against one and one-half units of hæmolysin. Both titrations were conducted at 37.5° C. for thirty minutes. The antigen consisted of a suspension of *Trypanosoma evansi* and was prepared from infected rats as described by Reynolds and Schoening.(1) The stock antigen was usually diluted 1: 20 and titrated in the presence of known positive and negative serums and two units used as the antigenic test dose, provided twice the antigenic dose was not anticomplementary in the presence of a negative serum. Complement and antigen were added to the serum and incubated at 37.5° C. for forty-five minutes. The hæmolysin and washed sheep cells were added, incubation continued for thirty minutes, and the tests read.

With this technic serum, antigen, and hæmolytic-system controls showed complete hæmolysis, although it was noted that in many of those serums later proven to have given pseudoreactions, the serum control tubes were slower to show complete hæmolysis than in those giving negative reactions.

*Results with original technic.*—The results shown in Table 1 were obtained with serums from horses and mules imported into the Philippines, over 90 per cent of which had been in the Islands for at least one year.

TABLE 1.—*Results of complement-fixation test by original technic.*

| | Horses. | Mules. |
|---|---|---|
| Total examined | 147 | 304 |
| Strongly positive (4-plus) | None. | None. |
| Weakly positive (3-plus) | None. | 7 (2.3 per cent.) |
| Suspicious (2-plus or less) | 4 (2.7 per cent.) | 19 (6.2 per cent.) |

Practically parallel results were obtained by testing many of the reacting serums with a cholesterolized alcoholic extract of beef-heart antigen and to a lesser degree with equine infectious abortion and glanders antigens, indicating the nonspecific nature of these weak positive and suspicious reactions.

The test animals were bled with sterile needles into sterile test tubes and the serums recovered were free of bacterial contamination and hæmoglobin. If not tested within twenty-four hours the serums were preserved by using phenol to a concentration of 0.5 per cent. Inhibition of hæmolysis was more marked in serums separated as soon as the blood clotted than in those allowed to stand in contact with the clot for twenty-four hours.

Over 50 per cent of the serums giving pseudofixation reactions were obtained in animals during, or shortly after, an acute febrile condition of uncertain origin (temperature 40 to 40.5° C.) lasting for three to ten days. Repeated miscroscopical examinations and animal inoculation of the blood of these animals failed to reveal trypanosomes. Two mules, the serums of which showed the most constant and marked antilytic properties, were destroyed. Rats, rabbits, guinea pigs, horses, and mules injected with blood, spinal fluid, and organ emulsions from these mules, failed to develop any evidence of trypanosomiasis or change in their serum reactions. The autopsy findings on the two destroyed mules were negative with the exception of a few encapsulated parasitic nodules in the lungs and liver.

The opinion has been expressed(2) that one or more of the following factors—age of the animal, work, physical condition, and climate, particularly heat and humidity—tend to produce in the Philippine Islands this transitory febrile condition in both horses and mules. This febrile state evidently causes a metabolic disturbance that leads to the presence in the serum of a thermostabile component that is antilytic, and that may be demonstrated in varying amounts for a maximum of three months.

Serums from horses that had been in the Philippines less than three months did not give false positive or suspicious reactions. This group constituted slightly less than 10 per cent of the animals tested. No pseudoreactions were obtained in selected serums of horses and mules having microfilaria in their blood or those having intestinal parasites.

Mackenzie and Marshall(3) working with human serums of native dispensary patients in Northern Nigeria found 70 per cent to be anticomplementary, occurring most frequently in cases of human trypanosomiasis. The anticomplementary condition was thermostabile and while the significance of this phenomenon was not understood, it was strong enough to interfere with the satisfactory carrying out of the complement-fixation tests by their usual methods. They also found that in the hot season guinea-pig complement was of such poor quality that they were unable to use it. It has also been observed by the writer that hot weather and humidity may markedly affect the guinea pig as regards the hæmolytic activity of its serum.

We find the lytic activity of the complement usually to be uniform if obtained from at least three healthy, nonpregnant guinea pigs weighing about 400 to 500 g each that have not been fed for sixteen hours. It was found that removing drinking water in the fasting period, or removing the animals from their open pens to the laboratory overnight before bleeding, markedly reduced the lytic activity of the complement. The guinea pigs were bled from the heart on the morning of the test, the clots held at 37° C. for one hour, separated, and then centrifuged to recover the clear serum.

To lessen the chances of hæmagglutinins interfering with hæmolysis the antisheep hæmolytic system was varied to include washed erythrocytes from two sheep, and hæmolysins prepared against them, and complement serums obtained from widely separated groups of guinea pigs. These combinations were used without a great variance in the results obtained.

This experience with the false reactions indicated that the prescribed hæmolytic system was too closely adjusted for conditions in the Philippine Islands. It was found that in using one and one-half units each of complement and hæmolysin an insufficient amount of complement was left to activate completely the hæmolytic system at the end of a test on some negative serums. These findings lead to an effort to modify the technic to meet local conditions.

The equipment required for the original technic was not available in sufficient quantity for the volume of work this problem entailed. To utilize the standard Army Wassermann equipment on hand, also to effect an economy of reagents, the necessary modifications were made.

In addition, the method of preparing the antigen was modified and the hæmolytic system adjusted in an attempt to avoid oversensitiveness and still retain the desired degree of specificity.

## MODIFIED TECHNIC

For each specimen three tubes containing 0.5 cc of physiological sodium chloride solution are employed with 0.1 cc and 0.05 cc, respectively, of serum for the test proper, and 0.1 cc of serum in the control tube. Inactivation of the serums is carried out as in the original technic.

The hæmolytic system contains 0.25 cc of 3 per cent washed sheep cells, two units of hæmolysin so diluted as to be contained in 0.25 cc, and two units of 10 per cent pooled guinea-pig complement, in contrast to some systems that use as high as five units of hæmolysin. The unit of complement is determined by titrating with two units of hæmolysin to prevent an excess of hæmolysin from lowering the volume of complement beyond the minimum required to avoid pseudocomplement fixation. It will be shown later that in antilytic serums the complement is absorbed and if the amount used in the test is low due to a large dose of hæmolysin, nonspecific complement-fixation reactions will occur due to an unbalanced hæmolytic system.

The complement is discarded if the unit as determined by the titration is below 0.05 cc or above 0.07 cc. The unit of complement is that amount contained in the first tube showing complete, crystal-clear hæmolysis when read through the bottom by means of a perforated tube rack.

The antigen is prepared according to the original method except that the citrated rat blood is centrifuged for four to five minutes at 2,000 revolutions to throw the red cells to the bottom of the centrifuge tubes. The supernatant and stratum of trypanosomes are collected nearly free of red blood cells. This method reduces the number of unlaked red blood cells and the amount of stroma from hæmolyzed cells in the finished antigen. The unit of antigen is always smaller than with the original technic and gives a much wider range between the antigenic and the anticomplementary doses. In the test three antigen control tubes are included, containing one, two, and three test doses of antigen, respectively, to test its anticomplementary properties with the particular guinea-pig complement used.

*Comparative results with other types of antigens.*—Dahmen's(4) alcoholic and watery extracts of trypanosomes were also used as antigens in conducting complement-fixation tests for *Trypanosoma evansi* infection. Neither antigen showed any advantage over the one mentioned above. In addition, the time consumed in preparing antigens by his methods and the very small yield obtained are objectionable features.

*Sensitiveness and specificity of the modified technic.*—To test the sensitiveness and specificity of this modified technic, a horse was selected whose serum was not antilytic and the animal inoculated with 0.1 cc of guinea-pig blood containing *Trypanosoma evansi.* Fresh blood films were examined and the temperature taken daily. On the seventh day the temperature of the animal was elevated to 39.4° C. and a microscopic examination of the fresh blood revealed two trypanosomes per microscopic field; the complement-fixation test was negative. The following day the complement-fixation test was one-plus and eight trypanosomes were found per field. On the following, or ninth day, the complement fixation was three-plus with only three trypanosomes per field, and on the following, or tenth day after inoculation, the complement fixation was four-plus and continued so for the duration of the infection. It has also been found in other cases that about seventy-two hours after the first finding of trypanosomes in the blood the complement-fixation test becomes strongly positive.

## PROPERTIES OF THE ANTILYTIC SERUMS

By conducting the complement-fixation tests with the modified technic, the number of serums that had formerly given false weakly positive and suspicious reactions was materially reduced but not entirely eliminated.

*Determination of the antilytic titer of the serums.*—Serums from those animals which gave the more-pronounced reactions were obtained and tested to determine their effect on the complementary activity of guinea-pig serum in comparison with known positive and nonreacting negative serums. This was determined by adding increasing amounts of 10 per cent complement to a series of ten tubes containing 0.1 cc of the particular inactivated serum in 0.5 cc of physiological sodium chloride solution, followed by incubation in the water bath at 37.5° C. for forty-five minutes. Two units of hæmolysin and 0.25 cc of a 3 per cent suspension of washed sheep cells were added to each tube and incubation continued for thirty minutes. The extent of the antilytic properties of each serum was then determined by comparing with a control series titrated without the addition of serum. The experiment was repeated with the addition of one test dose of antigen to each tube at the time the complement was added.

Table 2 shows that serum from Army horses and mules in the Philippine Islands will, at times, if obtained while the animal is in an acute febrile state and to lesser degrees for varying periods thereafter, contain a thermostabile component that is markedly antilytic. With the addition of antigen it is shown that the degree of pseudoreactions obtained is greater than the summation of the antilytic effect of the particular serum and the test dose of antigen.

TABLE 2.—*Antilytic titer of negative serums with and without antigen.*

[S = Complement titration plus 0.1 cc of inactivated mule serum. A = One dose of antigen added.]

| | | Cubic centimeter of 10 per cent complement. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 |
| Complement titration | | + | + | — | — | — | — | — | — | — | — |
| Complement titration with antigen | | + | + | + | — | — | — | — | — | — | — |
| Mule 1 | S | + | + | + | + | + | — | — | — | — | — |
| | S+A | + | + | + | + | + | + | + | + | — | — |
| Mule 2 | S | + | + | + | + | + | + | + | — | — | — |
| | S+A | + | + | + | + | + | + | + | + | + | — |
| Mule 3 | S | + | + | + | + | + | + | — | — | — | — |
| | S+A | + | + | + | + | + | + | + | + | + | — |
| Mule 4 | S | + | + | + | + | + | + | — | — | — | — |
| | S+A | + | + | + | + | + | + | + | + | — | — |
| Control mule | S | + | + | + | — | — | — | — | — | — | — |
| | S+A | + | + | + | + | + | — | — | — | — | — |
| Control horse | S | + | + | — | — | — | — | — | — | — | — |
| | S+A | + | + | + | — | — | — | — | — | — | — |
| Filaria infected horse | S | + | + | + | — | — | — | — | — | — | — |
| | S+A | + | + | + | + | + | — | — | — | — | — |

*Duration of antilytic properties.*—To determine the persistence of this antilytic property of serums occurring in febrile states, two mules with temperatures above 40° C. were bled and the antilytic titer of their serums determined. This was repeated after six days when the animals' temperatures had returned to normal and again after approximately a year. As shown in Table 3, marked antilytic properties were demonstrated during the febrile state, diminishing six days after when the temperatures were normal, and found to have disappeared after a lapse of approximately a year.

TABLE 3.—*Titer and duration of antilytic properties in mule serums.*

[A = Serums obtained while mules were in acute febrile state. B = Serums obtained six days after temperatures had returned to normal. C = Serums obtained approximately one year later.]

| | | Cubic centimeter of 10 per cent complement. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 |
| Complement titration | | + | + | + | — | — | — | — | — | — | — |
| Mule C423 | A | + | + | + | + | + | + | + | — | — | — |
| | B | + | + | + | + | + | — | — | — | — | — |
| | C | + | + | + | + | — | — | — | — | — | — |
| Mule 2C52 | A | + | + | + | + | + | + | — | — | — | — |
| | B | + | + | + | + | — | — | — | — | — | — |
| | C | + | + | + | — | — | — | — | — | — | — |

*Tests for native complement and antisheep hæmolysin in the antilytic serums.*—There is an apparent tendency of certain pathologic conditions, especially of a febrile nature, to increase the anticomplementary properties of the serum, and in these conditions there occurs, at times, a known diminution of native complement. Coca,(5) working with serums from a strain of guinea pigs that were lacking in complement, found that the midpiece and endpiece of the complement is present but the thirdpiece is very small in amount. This lacking portion, which is thermostabile, can be replaced by adding inactivated guinea-pig or human serum containing this third component, thereby enhancing the hæmolytic activity of the complement about three times.

No native complement could be demonstrated in the active serums included in Table 2. This may have been due to the masking effect of the antilytic properties of the serums. In amounts as low as 0.025 cc certain active mule serums were found to inhibit hæmolysis with two units of guinea-pig complement and two units of hæmolysin, nor could native complement be demonstrated when the experiment was repeated with the addition of either inactivated human or guinea-pig serums. In addition, native antisheep hæmolysin could not be demonstrated.

*Auxilytic effect of inactivated guinea-pig serums with inactivated antilytic serums.*—Havens and Frank(6) titrated twelve lots of normal guinea-pig serums in different combinations and found that the addition to each tube of 0.1 cc of inactivated human serum containing the thermostabile component of complement had fortified the complementary action of eleven of them, so that less of the latter was required to cause complete hæmolysis. Their work indicates that the complementary activity of normal serum complement can be enhanced by the addition of an inactivated serum containing the third or thermostabile component of complement. Hyde(7) in his work demonstrated that the thermostabile portion of complement may be removed by absorption with yeast.

To determine what effect the addition of inactivated guinea-pig serum containing the thermostabile portion of complement to known antilytic inactivated mule serums would have on the complementary activity of guinea-pig complement, the following experiments were conducted:

1. After several trials a guinea-pig complement was obtained that was not enhanced by the addition of inactivated guinea-pig serum in amounts used in the subsequent determinations.

2. The inactivated mule serums, known to be antilytic, were tested individually in 0.1 cc amounts to determine their effect on the complementary activity of the guinea-pig complement. The procedure was repeated with the addition of 0.01 cc per tube of inactivated guinea-pig serum and the effect noted.

3. The above titrations were repeated with one of the mule serums that had been absorbed with yeast.

TABLE 4.—*Auxilytic effect of inactivated guinea-pig serum with antilytic mule serums.*

[S=Complement titration plus 0.1 cc of inactivated mule serum. SY=Same as S but serum absorbed with yeast. G=0.01 cc of inactivated guinea-pig serum added.]

| | | Cubic centimeter of 10 per cent complement. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 |
| Complement titration | | + | + | — | — | — | — | — | — | — | — |
| 0.01 cc inactivated guinea-pig serum added | | + | + | — | — | — | — | — | — | — | — |
| Mule 28W1 | S | + | + | + | + | + | + | — | — | — | — |
| | S+G | + | + | + | + | — | — | — | — | — | — |
| Mule E116 | S | + | + | + | + | + | — | — | — | — | — |
| | S+G | + | + | + | — | — | — | — | — | — | — |
| Mule BO39 | S | + | + | + | + | + | — | — | — | — | — |
| | S+G | + | + | + | — | — | — | — | — | — | — |
| Mule BO39 | SY | + | + | + | + | + | + | + | — | — | — |
| | SY+G | + | + | + | + | + | — | — | — | — | — |

The results are shown in Table 4. It was found that while inactivated guinea-pig serum in amounts of 0.01 cc per tube in the complement titration did not enhance the complementary power for this particular guinea-pig complement, the addition of the same amount of inactivated guinea-pig serum markedly reduced the antilytic properties of the inactivated mule serums. It was also found in inactivated mule serum absorbed with yeast that the antilytic range of the serum was increased, whereas the addition of 10 per cent inactivated guinea-pig serum to the same yeast-absorbed serum reduced the antilytic properties, apparently showing that the antilytic mule serum had contained the thermostabile portion of native complement.

Serums from *Trypanosoma evansi*-infected animals were then run in duplicate, with and without the addition of 0.01 cc per tube of inactivated guinea-pig serum, for the determination of the complement-fixing units. The results showed that the addition of the inactivated guinea-pig serum did not reduce the titer of the positive serums although the antilytic properties of certain negative serums were somewhat reduced.

*The absorption of "protectin" from antilytic mule serums with sheep erythrocytes.*—According to Noguchi (8) antilytic serums may contain lipoidal substances designated by him as "protectin" which are absorbed by the erythrocytes of the hæmolytic system, thereby increasing their resistance to hæmolysis. Kolmer (9) states that he has not found sheep erythrocytes exposed to human, rabbit, and dog serums, previously heated for periods from one-half to three hours at 56° to 58° C., to acquire any increased resistance to either serum or saponin hæmolysis, but found the corpuscles were usually somewhat more susceptible to these agents than the control suspension.

Of the three mule serums included in Table 4, one was found to be less antilytic after absorption and the sheep erythrocytes used for absorption more resistant to hæmolysis. No change was observed in the other two serums, nor in the cells used, showing that the antilytic properties in the serums under discussion are not wholly dependent upon the presence of "protectin."

*Influence of heat on antilytic properties and complement-fixing antibodies in serums.*—The complement-inhibiting properties of certain antilytic horse and mule serums that had been determined after inactivating horse serums at 58° C. for thirty minutes and mule serums at 62° C. for thirty-five minutes were inactivated at 60° and 65° C., respectively, for the same periods of time. The antilytic properties were only slightly decreased in the horse serums but showed a decided decrease in the mule serums. The titers of positive mule serums run as checks at 65° C. were reduced to such an extent as to preclude this temperature as the proper inactivating temperature for mule serums. Only two positive horse serums were available at this time and the diminution of their titers was so slight as to be of no great consequence.

*Antilytic component of the albumin and globulin fractions of the serums.*—Kolmer (9) states that it has been the general result of his experiments that both the thermolabile and thermostabile antilysins of human serum and spinal fluid are associated with the globulin fractions. To determine what fractions of antilytic mule serums contained the thermostabile antilysins, two of the antilytic mule serums were fractioned by adding ammonium sulphate to 50 per cent of saturation. The precipitate containing the globulin fractions was removed by filtration. The globulin fractions and the filtrate containing the albumin fraction were dialyzed against running water for seventy-two hours to remove the ammonium salt. A few drops of chloroform were added to the dialyzed material as a preservative. The fractions were adjusted to the original volume of the serum with sodium chloride solution. The fractions and original serums were then inactivated and titrated in amounts to represent 0.1 cc of serum against graduated doses of 10 per cent complement. It was found that while the globulin fractions were the more antilytic the albumin fraction showed marked antilytic properties.

## THE ADJUSTMENT OF THE HÆMOLYTIC SYSTEM

Kolmer(9) states that in building up a hæmolytic system it is of prime importance to so adjust the quantities of corpuscles and hæmolysin that the complement unit will never fall below a certain minimum because the amount or unit of complement required for complete lysis of a given amount of corpuscles may be reduced so greatly by an excess of powerful hæmolysin as to render the unit entirely worthless in complement-fixation tests, owing to the anticomplementary effects of antigen and serum alone and the deterioration of complement during the period of primary incubation. Conversely, a deficiency in hæmolysin in the complement-fixation test may also result in false reactions with negative serums.

*Effect of increasing the units of hæmolysin.*—An attempt was made to determine if increasing the number of units of hæmolysin would compensate for a deficiency of complement due to its nonspecific fixation by certain horse and mule serums that in some instances approximated the one and one-half units formerly used in the routine test. These antilytic horse and mule serums from animals free of trypanosomiasis were tested with hæmolytic systems composed of three units of hæmolysin with one unit and one and one-half units of complement, respectively, the complement unit having been determined by titration with three units of hæmolysin.

Table 5 shows that although the number of units of hæmolysin is increased the amount of complement serum used in the test is lowered to such an extent that there is an increase in the number and degree of pseudoreactions. It is also shown that with these hæmolytic systems many of the serum-control tubes did not completely hæmolyze.

TABLE 5.—*Effect of increasing the units of hæmolysin.*

| Animal. | Three units of hæmolysin. | | | |
|---|---|---|---|---|
| | One unit of complement. | | One and one-half units of complement. | |
| | Test proper. | Serum control tube. | Test proper. | Serum control tube. |
| Mule 1 | +++ | + | ++ | — |
| Mule 2 | +++ | ++ | ++ | ± |
| Mule 3 | +++ | ++ | +++ | + |
| Mule 4 | +++ | ++ | ++ | ± |
| Mule 5 | +++ | + | ++ | — |
| Mule 6 | ++++ | +++ | +++ | ++ |
| Mule 7 | +++ | ++ | +++ | + |
| Mule 8 | ++ | — | + | — |
| Horse 1 | ++ | + | — | — |
| Horse 2 | + | ± | ± | — |
| Horse 3 | + | ± | ± | — |
| Horse 4 | ++ | + | ± | — |

*Comparative results with two exact and two full units of complement.*—These serums were retested with hæmolytic systems containing (*a*) two exact units of complement and two units of hæmolysin and (*b*) two full units of complement and two units of hæmolysin, the complement unit having been determined by titration with two units of hæmolysin. The full unit of complement was a modification of Kolmer's full unit as antigen was omitted during the titration.

As shown in Table 6, two units of hæmolysin with two units of complement markedly reduced the number of pseudoreactions, while two units of hæmolysin with two full units of complement gave a negative reaction in each instance.

Comparative tests were made on serums of horses and mules infected with *Trypanosoma evansi*, using hæmolytic systems as in (*a*) and (*b*) above. Serums from animals in the early stages of the disease that gave weakly positive and suspicious reactions in the former system would at times give reactions that were only suspicious or occasionally negative when tested with a system containing two full units of complement. Serum obtained forty-eight to seventy-two hours after the original specimen was collected usually gave a positive reaction with both hæmolytic systems showing a rapid rise in the titer of the complement-fixing antibodies.

TABLE 6.—*Effect of increasing the units of complement.*

| Animal. | Two units of hæmolysin. | | | |
|---|---|---|---|---|
| | Two exact units of complement. | | Two full units of complement. | |
| | Test proper. | Serum control tube. | Test proper. | Serum control tube. |
| Mule 1 | + | — | — | — |
| Mule 2 | ++ | — | — | — |
| Mule 3 | ++ | — | — | — |
| Mule 4 | + | — | — | — |
| Mule 5 | ± | — | — | — |
| Mule 6 | ++ | ± | — | — |
| Mule 7 | ± | — | — | — |
| Mule 8 | — | — | — | — |
| Horse 1 | — | — | — | — |
| Horse 2 | — | — | — | — |
| Horse 3 | — | — | — | — |
| Horse 4 | — | — | — | — |

## RESULTS WITH THE MODIFIED TECHNIC

With the modified complement-fixation test for trypanosomiasis, using a hæmolytic system containing two exact units each of complement and hæmolysin, over 1,000 serums have been examined routinely and the results obtained have been very satisfactory. However, it is essential with serums giving weakly positive or suspicious reactions, to determine the antilytic titer of the particular serum by titrating with graduated doses of complement, two units of hæmolysin, and without antigen. If antilytic, the particular serum is retested with the additional amount of complement that the serum is shown to absorb or neutralize.

## SUMMARY

In performing the complement-fixation test for trypanosomiasis in the Philippine Islands, some weakly positive and suspicious reactions have occurred in horses and mules free of trypanosomiasis. These have been shown to be pseudoreactions due to a thermostabile antilytic component in the serums. This phenomenon occurs frequently during, and for some period following, an acute febrile state of unknown origin.

The properties of these antilytic serums have been investigated by various methods and the results recorded. The nature of the antilytic substance or component has not been determined.

A modification of the complement-fixation test for trypanosomiasis is presented which in the Philippine Islands has resulted in the practical elimination of the pseudoreactions formerly obtained.

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# MALARIA AND ANOPHELES RECONNAISSANCE IN THE PHILIPPINES, II [1]

By PAUL F. RUSSELL

*Of the International Health Division of the Rockefeller Foundation*

ONE PLATE

## INTRODUCTION

This paper continues the report of Holt and Russell(1) on the incidence of malaria in the Philippines, presenting new data and a resumé of spleen and blood surveys. It will not be necessary, therefore, to review other malaria and *Anopheles* surveys made in the past, as this was done in the first paper,(1) where there was also given a brief discussion of climatological conditions in the Philippines, with maps and tables.

## SPLEEN RECONNAISSANCE

The conclusions of the first report as regards the value of spleen rates in a malaria reconnaissance in the Philippines are still held. Here, as elsewhere, the spleen index appears to be what Ross, Christophers, and Perry(2) called it, the "most readily and extensively applicable, and at the same time the most reliable measure of the amount of malaria in a community."

The technic of examination has been, wherever possible, the more sensitive method of Darling.(3) The child is placed in a recumbent position with thighs and legs flexed. The clothing is removed or loosened so that the hand of the examiner can be placed upon the bare skin of the abdomen. Standing at the child's right, the examiner gently but firmly explores the upper left quadrant of the abdomen with the finger tips, feeling for an enlarged spleen. If the spleen is not palpable, the child is instructed to inspire deeply. The tips of the fingers of the examiner's right hand are held just below the costal margin. As the child inspires, slight pressure is made with the fingers and sometimes the spleen, apparently pushed downwards by the diaphragm, becomes palpable.

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[1] The surveys and laboratory studies on which this paper is based were made by the staff of Malaria Investigations, a project jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. The Bureau of Health is coöperating through the assignment to Malaria Investigations of Mr. F. E. Baisas, chief malaria inspector, to whom the author is greatly indebted for collaborating in the identification of anopheline specimens. Thanks are also due Mr. A. M. Nono, and Mr. Domingo Santiago, chief field inspector and field inspector, respectively, of Malaria Investigations, for their collecting zeal. Finally, the author is indebted to Maj. G. C. Dunham, medical adviser to the Governor-General of the Philippine Islands, for his assistance several times during this reconnaissance.

Palpable spleens were classed as follows, after Boyd:(4)

| | |
|---|---|
| Spleen 0. | Not palpable. |
| Spleen P. | D. I. Palpable only on deep inspiration. |
| Spleen 1. | Palpable at the costal margin on normal respiration. |
| Spleen 2. | Palpable and extending halfway to the umbilicus. |
| Spleen 3. | Palpable and extending to the umbilicus. |
| Spleen 4. | Palpable and extending below the umbilicus. |

On the basis of the experience of the surveys reported here and in the first paper(1) it appears that spleen rates of more than 5 per cent are indicative of malaria. But unless the spleen rate is more than 10 per cent there is probably no transmission of malaria in the community. Rates between 5 and 10 per cent have pointed to imported cases. For example, in the barrio of Camp Labi there was no indication of malaria transmission, the carrying anopheline being absent and local histories negative. A spleen rate of 7 per cent was found. On investigation it was shown that some of the inhabitants had come from malarious regions and gave a positive history of malaria prior to coming to Camp Labi. In Manila, the spleen rate in 215 examinations was 3.3 per cent. This is probably a normal, nonmalarious rate. In 100 of these cases blood smears were taken and found negative. In Bay, Laguna, the spleen rate was 12.6 per cent. The carrying mosquito exists in Bay and there were positive histories showing that transmission undoubtedly occurs in Bay.

The spleen survey statistics are given in Tables 1 and 2. As noted in the first table, a total of 991 spleen examinations are reported from seven provinces. Spleen rates varied from 3.0 in Manila and 3.5 in Cebu to 90.0 in Bongabong Saw Mill and 68.1 in Puerto Princesa.

In Table 2, spleen palpations are summarized by provinces, including those reported in the first paper. The total is 8,791, in 122 localities, with 1,655 or 18.8 per cent palpable. Percentages by provinces are not given for they may be misleading. Not enough samples have been taken yet from the various provinces to give a fair grading as regards malaria. As elsewhere, so in the Philippines, malaria is not evenly distributed. In most provinces there are nonmalarious areas, and also localities where malaria is faintly, mildly, or severely endemic. The disease is found in every province in the Archipelago and is probably being transmitted in every one but Manila. The spleen surveys have borne out the conclusion of the first paper(1) that malaria in the Philippines is primarily a disease of foothill regions.

## PARASITE STUDIES

The results of blood-smear examinations are given in Tables 3, 4, and 5. It will be noted that in a total of 1,065 examinations, reported in Table 3, there were 264, or 24.8 per cent, positive smears. Of the species, *Plasmodium vivax* was commonest and *P. malariæ* was least often found.

In Table 4, the results of the first reconnaissance have been included, making a total of 2,302 blood-smear examinations with 544, or 23.6 per cent, positive.

Table 5 reveals a correlation between spleen size and percentage of positive smears. Only 1.7 per cent of those with negative spleens and whose blood was examined had a positive smear. Of those having a size 4 spleen, 87.5 per cent were also blood positive. It is interesting to note that 54.4 per cent of those whose spleens were only palpable on deep inspiration had positive blood smears.

## ANOPHELES RECONNAISSANCE

In this report practically the same classification is used as was given (with some misprints) in the first paper(1) although this is provisional and will doubtless have to be modified. This classification is as follows:

1. *Anopheles aitkeni* var. *bengalensis* Puri, 1930.
2. *Anopheles barbirostris* van der Wulp, 1884.
3. *Anopheles filipinæ* Manalang, 1930.
4. *Anopheles fuliginosus* Giles, 1900.
5. *Anopheles gigas* var. *formosus* Ludlow, 1909.
6. *Anopheles hyrcanus* var. *nigerrimus* Giles, 1900.

7. *Anopheles hyrcanus* var. *sinensis* Wiedemann, 1828.
8. *Anopheles insulæflorum* Swellengrebel and Swellengrebel de Graaf, 1920.
9. *Anopheles karwari* James, 1903.
10. *Anopheles kochi* Dönitz, 1901.
11. *Anopheles leucosphyrus* Dönitz, 1901.
12. *Anopheles lindesayi* var. *benguetensis* King, 1931.
13. *Anopheles litoralis* King, 1932. ("Salt-water *ludlowi*.")
14. *Anopheles ludlowi* Theobald, 1903. ("Fresh-water *ludlowi*.")
15. *Anopheles maculatus* Theobald, 1901.
16. *Anopheles mangyanus* Banks, 1907.
17. *Anopheles minimus* var. *flavirostris* Ludlow, 1914.
18. *Anopheles parangensis* Ludlow, 1914.
19. *Anopheles philippinensis* Ludlow, 1902.
20. *Anopheles pseudobarbirostris* Ludlow, 1902.
21. *Anopheles subpictus* var. *indefinitus* Ludlow, 1904. ("*A. rossi*.")
22. *Anopheles tessellatus* Theobald, 1901.
23. *Anopheles umbrosus* Theobald, 1903 (variety).
24. *Anopheles vagus* var. *limosus* King, 1932.
25. *Anopheles kolambuganensis* Baisas, 1931.
26. *Anopheles* species from Balabac, Palawan. (?)
27. *Anopheles aitkeni* variety from Banahao, Laguna. (?)

In the above list Nos. 25 to 27 were not given in the first report. Descriptions of Nos. 26 and 27 will be published in due time. The *funestus-minimus* subgroup (see King, 5) has been greatly confused in the past. For example, probably *A. mangyanus* has included *A. minimus* var. *flavirostris* and *A. filipinæ*. It seems likely that *A. minimus* var. *flavirostris* has included "*A. funestus*," "*A. minimus*," *A. filipinæ*, and *A. mangyanus*.

The species of anopheles larvæ collected are listed in Table 6 by localities and type of breeding place. This table includes collections made in twenty-two provinces in the year 1933. If the collections reported in the first paper(1) are included, then forty-eight of the forty-nine provinces are represented, only Camarines Norte being unvisited in this reconnaissance. In this province, therefore, as well as in Capiz, Iloilo, Manila, Romblon, and Surigao, the important *A. minimus* var. *flavirostris* has not been reported in the table of this reconnaissance. In the case of all but Manila this is due to the inadequacy of the collecting and not to an absence of this anopheline. The species apparently does not exist in Manila, as numerous collections have not shown it. However, in San Francisco del Monte, a suburb of Manila, in Rizal Province, *A. minimus* var. *flavirostris* has been found.

The collections reported in this paper continue to bear out the observations of the first report(1) in that malaria and *A. minimus* var. *flavirostris* are closely associated, more so than in the case of any other species. In the first paper it was noted that *A. barbirostris* was also frequently found in malarious places. But this species has never been found infected in nature. Walker and Barber(6) were able to infect six in one hundred *A. barbirostris* experimentally. But Manalang(7) in several thousand dissections of wild-caught *A. barbirostris* has not found this mosquito infected. It does not appear to play an important rôle in the transmission of malaria in the Philippines, if indeed it has any rôle at all.

In Table 6 all of the local anophelines are represented in the collections excepting *A. gigas* var. *formosus.* This species was reported in the first paper(1) so that during this reconnaissance all of the accepted species of anophelines in the Islands have been collected, as well as an apparently new species from Balabac, Palawan, and a new variety from Banahao, Laguna. These will be described in another paper. It also appears that certain larvæ called *A. umbrosus* are really *A. baezai* Gater, 1933, hitherto unreported from the Philippines. This finding will also be discussed in due time.

The number of times each species has been collected is shown in Table 7 and the association of certain species is shown in Table 8. It will be seen that *A. barbirostris* and *A. minimus* var. *flavirostris* have been most often taken; also that the association between these two species is the commonest one encountered.

## CONCLUSIONS

In a continuation of the malaria reconnaissance of Holt and Russell(1) in the Philippines, new data are presented which are in line with the conclusions of the first paper. As a result of the combined studies it is concluded that:

1. Malaria is widespread throughout the Philippine Archipelago.
2. The disease is primarily one of foothill regions, being found wherever there are streams containing the larvæ of *A. minimus* var. *flavirostris.* The littoral when flat, the inland plains, and the mountains above 2,000 feet are not malarious.
3. Spleen palpations furnish a useful index to the incidence of malaria in Philippine communities.
4. There is a positive correlation between degree of splenic enlargement and percentage of positive blood smears.

TABLE 1.—*Spleen survey by locality and size of spleen.*

| Province and locality. | Date. | Examined. | Negative. | Size of spleen. | | | | | Positive. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P. D. I. | 1 | 2 | 3 | 4 | Number. | Per cent. |
| Bataan: | | | | | | | | | | |
| Mariveles | Apr., 1932 | 48 | 44 | 4 | ---- | ---- | ---- | ---- | 4 | 8.4 |
| Cabcaban | Apr., 1932 | 11 | 5 | ---- | 5 | ---- | 1 | ---- | 6 | 54.5 |
| Cebu: | | | | | | | | | | |
| Cebu | Oct., 1933 | 136 | 131 | 3 | 1 | 1 | ---- | ---- | 5 | 3.5 |
| Laguna: | | | | | | | | | | |
| Bay | Nov.,1933 | 86 | 75 | 5 | 5 | 1 | ---- | ---- | 11 | 12.6 |
| Calauan | Nov.,1933 | 76 | 45 | 16 | 7 | 5 | 2 | 1 | 31 | 40.0 |
| Magdalena | Nov.,1933 | 72 | 34 | 14 | 17 | 5 | 2 | ---- | 38 | 52.5 |
| Manila: | | | | | | | | | | |
| San Andres School | Oct., 1933 | 100 | 97 | 3 | ---- | ---- | ---- | ---- | 3 | 3.0 |
| Nueva Ecija: | | | | | | | | | | |
| Camp Labi | June, 1933 | 41 | 38 | 3 | ---- | ---- | ---- | ---- | 3 | 7.0 |
| Bongabong Saw Mill | June, 1933 | 10 | 1 | 2 | 3 | 2 | 2 | ---- | 9 | 90.0 |
| Bongabong Lower Camp | June, 1933 | 10 | 9 | ---- | 1 | ---- | ---- | ---- | 1 | 10.0 |
| Nueva Vizcaya: | | | | | | | | | | |
| Aritao | Feb., 1933 | 30 | 20 | 4 | 3 | 2 | 1 | ---- | 10 | 33.3 |
| Palawan: | | | | | | | | | | |
| Culion nonleper school | Dec.,1933 | 84 | 72 | 9 | 3 | ---- | ---- | ---- | 12 | 14.0 |
| Culion leper school | Dec.,1933 | 28 | 26 | 2 | ---- | ---- | ---- | ---- | 2 | 7.0 |
| Iwahig school | Dec.,1933 | 146 | 107 | 25 | 9 | 2 | 3 | ---- | 39 | 26.7 |
| Puerto Princesa School | Dec.,1933 | 113 | 36 | 31 | 27 | 12 | 6 | 1 | 77 | 68.1 |
| Total | ---- | 991 | 740 | 121 | 81 | 30 | 17 | 2 | 251 | 25.3 |

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TABLE 2.—*Spleen examinations by provinces.*

| Province. | Localities visited. | Examined. | Positive. |
|---|---|---|---|
| Abra | 2 | 160 | 48 |
| Albay | 3 | 186 | 21 |
| Antique | 1 | 115 | 18 |
| Bataan | 12 | 1,135 | 144 |
| Batangas | 4 | 298 | 47 |
| Cagayan | 4 | 164 | 33 |
| Camarines Sur | 3 | 184 | 42 |
| Capiz | 1 | 89 | 2 |
| Cebu | 1 | 225 | 7 |
| Davao | 4 | 175 | 10 |
| Ilocos Norte | 3 | 287 | 93 |
| Ilocos Sur | 3 | 187 | 50 |
| Isabela | 2 | 126 | 34 |
| Laguna | 7 | 618 | 202 |
| La Union | 3 | 164 | 33 |
| Leyte | 2 | 118 | 18 |
| Manila | 3 | 215 | 7 |
| Masbate | 1 | 99 | 7 |
| Mindoro | 3 | 103 | 55 |
| Mountain | 4 | 79 | 0 |
| Nueva Ecija | 7 | 256 | 97 |
| Nueva Vizcaya | 5 | 178 | 136 |
| Palawan | 4 | 371 | 130 |
| Pampanga | 4 | 1,143 | 38 |
| Pangasinan | 4 | 251 | 32 |
| Rizal | 1 | 99 | 3 |
| Samar | 1 | 47 | 13 |
| Sorsogon | 4 | 220 | 38 |
| Sulu | 10 | 578 | 130 |
| Tayabas | 7 | 386 | 54 |
| Zambales | 5 | 224 | 27 |
| Zamboanga | 4 | 311 | 86 |
| Total | 122 | 8,791 | 1,655 |

TABLE 3.—*Blood smear examinations by locality and findings.*

| Province and locality. | Examined. | Positive. | | Species of *Plasmodium*. | | | | | Date. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Vivax.* | *Falciparum.* | *Malariæ.* | Undetermined. | Mixed. | |
| | | | *P.ct.* | | | | | | |
| Cebu: | | | | | | | | | |
| Cebu | 5 | 0 | 0.0 | | | | | | Oct., 1933. |
| Laguna: | | | | | | | | | |
| Bay | 86 | 6 | 7.0 | 3 | 2 | | 1 | | Nov., 1933. |
| Calauan | 76 | 22 | 28.8 | 15 | 7 | | 1 | 1 | Nov., 1933. |
| Magdalena | 72 | 33 | 45.8 | 16 | 18 | | 1 | 2 | Nov., 1933. |
| Manila: | | | | | | | | | |
| San Andres School | 100 | 0 | 0.0 | | | | | | Oct., 1933. |
| Nueva Ecija: | | | | | | | | | |
| Bongabong Saw Mill | 7 | 5 | 71.4 | 3 | 2 | | | | July, 1933. |
| Nueva Vizcaya: | | | | | | | | | |
| Aritao | 300 | 95 | 31.7 | 67 | 26 | 2 | | | Feb., 1933. |
| Palawan: | | | | | | | | | |
| Culion, nonleper school | 83 | 5 | 6.0 | 3 | 1 | | 1 | | Dec., 1933. |
| Culion, leper school | 28 | 0 | 0.0 | | | | | | Dec., 1933. |
| Culion, Pilapil | 16 | 5 | 31.3 | 1 | 5 | | | 1 | Dec., 1933. |
| Culion, Baldat | 24 | 11 | 45.8 | 4 | 7 | | | | Dec., 1933. |
| Culion, Patag | 9 | 1 | 11.1 | 1 | | | | | Dec., 1933. |
| Iwahig Penal Colony | 146 | 24 | 13.7 | 14 | 10 | | | | Dec., 1933. |
| Puerto Princesa School | 113 | 57 | 50.4 | 32 | 23 | 1 | 4 | 3 | Dec., 1933. |
| Total | 1,065 | 264 | 24.8 | 159 | 101 | 3 | 8 | 7 | |

TABLE 4.—*Summary of blood-smear examinations.*[a]

| | Number. | Per cent. |
|---|---|---|
| Provinces | 9 | |
| Localities | 20 | |
| Smears examined | 2,302 | |
| Smears positive | 544 | 23.6 |
| *Plasmodium vivax* | 328 | [b] 60.3 |
| *Plasmodium malariæ* | 6 | [b] 1.1 |
| *Plasmodium falciparum* | 244 | [b] 44.9 |
| Mixed | 29 | [b] 5.3 |
| Undetermined | 11 | [b] 2.0 |

[a] Table includes figures from the first report. (1) [b] Percentage of positive smears.

TABLE 5.—*Spleen size and blood smears.*[a]

| Spleen size. | Total smears. | Positive smears. | |
|---|---|---|---|
| | | Number. | Per cent. |
| Negative | 521 | 9 | 1.7 |
| P. D. I. | 114 | 62 | 54.4 |
| 1 | 109 | 71 | 65.1 |
| 2 | 52 | 36 | 69.2 |
| 3 | 26 | 19 | 73.1 |
| 4 | 8 | 7 | 87.5 |

[a] Includes figures from first report. (1)

TABLE 6.—*Anopheles larvæ taken during reconnaissance in 1933, listed by province, locality, and species.*

| Locality. | Lot No. | Date. | Larvæ.[b] | Breeding places.[b] | Remarks. |
|---|---|---|---|---|---|
| AGUSAN | | 1933 | | | |
| Ampayon, Butuan | R33 | May 13 | 2, 15, 16, 17 | S C G | |
| BATANES | | | | | |
| Basco | 5 | Mar. 27 | 17 | S C G | |
| San Pioquinto | 6 | Mar. 29 | 3, 15, 17 | S C U | |
| Do. | 7 | Mar. 29 | 2, 19 | P C U | |
| BUKIDNON | | | | | |
| Maloco | R35a | May 14 | 4, 19 | P C G | |
| Lonocan | R35b | May 14 | 17 | S C G | |
| CAGAYAN | | | | | |
| Aparri | 9a | Mar. 30 | 7 | W C G | |
| COTABATO | | | | | |
| Awang | R25a | May 7 | 17 | S C G | Copiton Creek. |
| Do. | R25b | May 7 | 2, 17 | S M G | Do. |
| Cocal | R25c | May 7 | 21 | O D M | |
| Cotabato | R25d | May 7 | | Canal | Cotabato Canal. No *Anopheles*. |
| Tibud | R26 | May 8 | 13 | O P U | West of Tinaca Light. |
| DAVAO | | | | | |
| Santa Ana | R27 | May 9 | 13 | O P U | |
| Matina | R27a | May 9 | 15, 16, 17 | S C G | |
| Mati | R29 | May 10 | 2, 15 | Tank | Spring water. |
| ILOCOS NORTE | | | | | |
| Deriquie | 4 | Mar. 26 | 2, 3, 17 | S C G | |
| ILOCOS SUR | | | | | |
| Vigan | 3a | Mar. 25 | 2, 3, 19, 21 | P C G | North of provincial building. |

| | | | | | |
|---|---|---|---|---|---|
| LAGUNA | | | | | |
| Calauan Mountain | 2, 2a, 2b | Mar. 9 | 2, 15, 16, 17 | S C G | |
| Calauan | ([a]) | | 2, 3, 6, 7, 10, 16, 17, 21, 22, 24 | Various | Routine collections. |
| Do | ([a]) | Apr. 26 | 2, 17 | W C G | Water 7 feet from surface of ground. |
| Los Baños | ([a]) | | 2, 11, 17 | S C G | Molawin Creek. |
| Banahao | 4-11 | Mar. 21-22 | 11, 12, 15, 27 | S C G | |
| San Antonio Mountain | 3a to j | Mar. 15 | 3, 4, 7, 9, 10, 24 | | |
| LANAO | | | | | |
| Kolambugan | | | 16, 17, 25 | S C G | |
| Boroon, Iligan | R37a | May 15 | 17 | S C G | |
| Tinoja, Iligan | R37b | May 15 | 17 | S C G | |
| Camp Overton | R37c | May 15 | 8 | S C U | |
| Abaga, Dansalan | R37d | May 15 | 17 | S C U B | |
| Lanao | R37e | May 15 | 21 | L C U | Lake Lanao. |

[a] Various.

[b] The species of mosquito larvæ collected are indicated by numbers and the types of breeding places by letters, as follows:

*Anopheles*—
1. *aitkeni* var. *bengalensis*.
2. *barbirostris*.
3. *filipinæ*.
4. *fuliginosus*.
5. *gigas* var. *formosus*.
6. *hyrcanus* var. *nigerrimus*.
7. *hyrcanus* var. *sinensis*.
8. *insulæflorum*.
9. *karwari*.

*Anopheles*—
10. *kochi*.
11. *leucosphyrus*.
12. *lindesayi* var. *benguetensis*.
13. *litoralis*.
14. *ludlowi*.
15. *maculatus*.
16. *mangyanus*.
17. *minimus* var. *flavirostris*.
18. *parangensis*.

*Anopheles*—
19. *philippinensis*.
20. *pseudobarbirostris*.
21. *subpictus* var. *indefinitus*.
22. *tessellatus*.
24. *vagus* var. *limosus*.
25. *kolambuganensis*.
26. Balabac species.
27. Banahaw variety.

BREEDING PLACES

S, stream.
R, river.
P, pool.
L, lake.

D, ditch, still.
I, irrigation ditch, flowing.
W, well.
O, ocean, salt water.
B, bamboo.

G, shaded.
U, unshaded.
C, clear.
M, muddy.

TABLE 6.—*Anopheles larvæ taken during reconnaissance in 1933, listed by province, locality, and species*—Continued.

| Locality. | Lot No. | Date. | Larvæ.[a] | Breeding places.[b] | Remarks. |
|---|---|---|---|---|---|
| LA UNION | | 1933 | | | |
| San Fernando | 1 | Mar. 24 | 13 | O P U | |
| Do | 2 | Mar. 24 | 17 | S C U | Overflow from a well. |
| MARINDUQUE | | | | | |
| Boac | R44a | May 23 | 14, 15 | R C U | Boac River. |
| Do | R44b | May 23 | 10, 14, 17 | S C G | Small stream in Boac. |
| Do | R44c | May 23 | 24 | P M U | |
| MINDORO | | | | | |
| Calapan | R45 | May 24 | 24 | P M U | |
| Cabra Island | R11 | Apr. 23 | | | No anophelines. |
| Apo Reef | R12 | Apr. 23 | | | Do. |
| Ambolong | R13 | Apr. 23 | | | Do. |
| NUEVA ECIJA | | | | | |
| Camp Labi | | July | 1, 2, 8, 15–16 | S C U | |
| Bongabon Saw Mill | | July | 2, 3, 8, 15, 16, 17 | S C U | |
| Balete Pass | | June | 3 16, 17 | S C G | Km. 194–195. |
| NUEVA VIZCAYA | | | | | |
| Aritao | | | 15, 17 | S C G | |
| OCCIDENTAL MISAMIS | | | | | |
| Jimenez | R39 | May 16 | 17 | D M U | |
| Oroquieta | R40 | May 16 | 17, 20 | D M U | |
| Tagolo Point | R41 | May 16 | 2, 17, 21 | S C G | |
| OCCIDENTAL NEGROS | | | | | |
| Pulupandan | R42a | May 19 | 13 | O P U | |
| Do | R42b | May 19 | 13 | O P U | |

| | | | | | | |
|---|---|---|---|---|---|---|
| ORIENTAL MISAMIS | | | | | | |
| Mambajao, Camiguin Island | R34a | May | 13 | 16, 17 | S M G | Behind church. |
| Do | R34b | May | 13 | 21, 24 | P C G | |
| Laposan, Cagayan | R36a | May | 14 | 13 | O P U | |
| Bigaan, Cagayan | R36b | May | 14 | 2, 3, 17 | R C G | Bigaan River. |
| Omalag, Cagayan | R36c | May | 14 | 2, 7, 20, 21 | P C G | |
| Agusan, Cagayan | R36d | May | 14 | 18, 21 | P C G | |
| PALAWAN | | | | | | |
| Culion, Baldat | R48b | Dec. | 5 | 2, 17 | S C G | North stream. |
| Do | R48c | Dec. | 5 | 17 | S C G | South stream. |
| Culion, Pilapil | R14a | Apr. | 25 | 19, 21 | P C U | |
| Do | R14b | Apr. | 25 | 13, 21 | O P U | |
| Do | R48d | Dec. | 5 | 17 | S C G | |
| Do | R48e | Dec. | 5 | 23 | O P U | (Probably *A. baezai.*) |

[a] Various.

[b] The species of mosquito larvæ collected are indicated by numbers and the types of breeding places by letters, as follows:

*Anopheles*—

1. *aitkeni* var. *bengalensis.*
2. *barbirostris.*
3. *filipinæ.*
4. *fuliginosus.*
5. *gigas* var. *formosus.*
6. *hyrcanus* var. *nigerrimus.*
7. *hyrcanus* var. *sinensis.*
8. *insulæflorum.*
9. *karwari.*

*Anopheles*—

10. *kochi.*
11. *leucosphyrus.*
12. *lindesayi* var. *benguetensis.*
13. *litoralis.*
14. *ludlowi.*
15. *maculatus.*
16. *mangyanus.*
17. *minimus* var. *flavirostris.*
18. *parangensis.*

*Anopheles*—

19. *philippinensis.*
20. *pseudobarbirostris.*
21. *subpictus* var. *indefinitus.*
22. *tessellatus.*
23. *umbrosus.*
24. *vagus* var. *limosus.*
25. *kolambuganensis.*
26. Balabac species.
27. Banahaw variety.

BREEDING PLACES

S, stream.
R, river.
P, pool.
L, lake.

D, ditch, still.
I, irrigation ditch, flowing.
W, well.
O, ocean, salt water.
B, bamboo.

G, shaded.
U, unshaded.
C, clear.
M, muddy.

TABLE 6.—*Anopheles larvæ taken during reconnaissance in 1933, listed by province, locality, and species*—Continued.

| Locality. | Lot No. | Date. | | Larvæ.[a] | Breeding places.[b] | Remarks. |
|---|---|---|---|---|---|---|
| | | 1933 | | | | |
| PALAWAN—continued | | | | | | |
| Culion, Patag | R14d | Apr. | 25 | 2 | P C G | Negative Barrio. |
| Do | R15e | Apr. | 25 | 2, 9, 17 | S C G | |
| Do | R48 | Dec. | 5 | 1, 17 | S C G | |
| Do | R48a | Dec. | 5 | 17 | S C U | Irrigation canal. |
| Iwahig, Gumbia | R15b | Apr. | 28 | 21 | D M U | |
| Iwahig, Quinina | R49, 49a | Dec. | 10 | 2, 17, 24 | R C G | |
| Iwahig, Malamig | R49d | Dec. | 10 | 17 | I C U | |
| Iwahig, Balsahan | R49e | Dec. | 10 | 17 | R C U | |
| Iwahig, Esperanza | R49i | Dec. | 12 | 7, 17, 21 | S C G | |
| Iwahig, Lakandoia | R49j | Dec. | 12 | 2, 6, 7, 17 | S C G | |
| Iwahig, Laundry | R49l | Dec. | 12 | 17 | S C G B | |
| Iwahig, Binuan | R49p | Dec. | 12 | 2, 17 | S M U | |
| Iwahig, East Central | R49q | Dec. | 13 | 23 | O P U | (Probably *A. baezai.*) |
| Puerto Princesa | R50 | Dec. | 15 | 17 | S M G | |
| Aborlan | R16a | Apr. | 28 | 2, 17 | S C G | Heraan stream. |
| Brooke's Point | R17 | Apr. | 29 | 17 | S C G | Pangobilihan stream. |
| Balabac | R18 | Apr. | 30 | 2, 26 | P C G | |
| RIZAL | | | | | | |
| Antipolo | R15, 16 | Dec. | 28 | 2, 3, 15, 17, 24 | S C G | |
| Wawa | 51b | Dec. | 28 | 2, 15, 24 | P C U | |
| Do | 51c | Dec. | 28 | 2, 3, 17 | S C U | Back of mill of Philippine Lime Corporation. |
| Do | 51d | Dec. | 28 | 2, 15, 16, 17 | S C U | |
| Do | 51e | Dec. | 28 | 2, 3, 15, 16, 17 | S C G | |
| ROMBLON | | | | | | |
| Romblon | R43 | May | 23 | 15 | P C G | Seepage from spring. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Romblon | R43 | May | 23 | 15 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| SULU | | | | | | |
| Cagayan, Lupa pula | R19a | May | 1 | 17 | S C G | Pillian Creek. |
| Do | R19b | May | 1 | 2, 15, 17 | W C G | Shallow well. |
| Do | R19c | May | 1 | 13, 23 | O P U | |
| Sibutu | R20 | May | 2 | | | No anophelines. |
| Jolo | R21a | May | 3 | 21 | O P U | In city. |
| Do | R21b | May | 4 | 21 | P C U | Asturias spring. |
| Do | R21c | May | 4 | 20, 21 | P C U | |
| Do | R21d | May | 4 | 21 | O D U | |
| SURIGAO | | | | | | |
| Surigao, Malico | R32 | May | 12 | 20 | D C U | |
| ZAMBOANGA | | | | | | |
| Zamboanga | R22 | May | 6 | 13, 21 | O P U | |
| Sibago Island | R23 | May | 6 | 21, 24 | P M G | |
| Langil Island | R24 | May | 6 | 13 | O P U | |

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[a] Various lots.

[b] The species of mosquito larvæ collected are indicated by numbers and the types of breeding places by letters, as follows:

*Anopheles*—

1. *aitkeni* var. *bengalensis.*
2. *barbirostris.*
3. *filipinæ.*
4. *fuliginosus.*
5. *gigas* var. *formosus.*
6. *hyrcanus* var. *nigerrimus.*
7. *hyrcanus* var. *sinensis.*
8. *insulæflorum.*
9. *karwari.*

*Anopheles*—

10. *kochi.*
11. *leucosphyrus.*
12. *lindesayi* var. *benguetensis.*
13. *litoralis.*
14. *ludlowi.*
15. *maculatus.*
16. *mangyanus.*
17. *minimus* var. *flavirostris.*
18. *parangensis.*

*Anopheles*—

19. *philippinensis.*
20. *pseudobarbirostris.*
21. *subpictus* var. *indefinitus.*
22. *tessellatus.*
23. *umbrosus.*
24. *vagus* var. *limosus.*
25. *kolambuganensis.*
26. Balabac species.
27. Banahaw variety.

BREEDING PLACES

S, stream.
R, river.
P, pool
L, lake.

D, ditch, still.
I, irrigation ditch, flowing.
W, well.
O, ocean, salt water.
B, bamboo

G, shaded.
U, unshaded.
C, clear.
M, muddy.

TABLE 7.—*Species of Anopheles encountered in survey and number of times found.*

| Species No. | Species name. | Times collected. | | |
|---|---|---|---|---|
| | | First report. | This report. | Total. |
| 1 | *aitkeni* var. *bengalensis* | 5 | 2 | 7 |
| 2 | *barbirostris* | 254 | 29 | 283 |
| 3 | *filipinæ* | 68 | 10 | 78 |
| 4 | *fuliginosus* | 35 | 2 | 37 |
| 5 | *gigas* var. *formosus* | 7 | 0 | 7 |
| 6 | *hyrcanus* var. *nigerrimus* | 17 | 2 | 19 |
| 7 | *hyrcanus* var. *sinensis* | 48 | 6 | 54 |
| 8 | *insulæflorum* | 14 | 3 | 17 |
| 9 | *karwari* | 2 | 2 | 4 |
| 10 | *kochi* | 6 | 3 | 9 |
| 11 | *leucosphyrus* | 0 | 2 | 2 |
| 12 | *lindesayi* var. *benguetensis* | 6 | 1 | 7 |
| 13 | *litoralis* | 10 | 10 | 20 |
| 14 | *ludlowi* | 25 | 2 | 27 |
| 15 | *maculatus* | 109 | 15 | 124 |
| 16 | *mangyanus* | 50 | 9 | 59 |
| 17 | *minimus* var. *flavirostris* | 378 | 48 | 426 |
| 18 | *parangensis* | 0 | 1 | 1 |
| 19 | *philippinensis* | 21 | 3 | 24 |
| 20 | *pseudobarbirostris* | 30 | 4 | 34 |
| 21 | *subpictus* var. *indefinitus* | 61 | 15 | 76 |
| 22 | *tessellatus* | 15 | 1 | 16 |
| 23 | *umbrosus* | 4 | 3 | 7 |
| 24 | *vagus* var. *limosus* | 53 | 8 | 61 |
| 25 | *kolambuganensis* | 0 | 1 | 1 |
| 26 | Balabac species | 0 | 1 | 1 |
| 27 | Banahao variety | 0 | 1 | 1 |

TABLE 8.—*Association of two or more species of Anopheles.*

| Species Nos. | Species in association. | Times found together. | | |
|---|---|---|---|---|
| | | First report. | This report. | Total. |
| 2 and 17 | *barbirostris* and *minimus* | 178 | 21 | 199 |
| 15 and 17 | *maculatus* and *minimus* | 101 | 9 | 110 |
| 16 and 17 | *mangyanus* and *minimus* | 25 | 8 | 33 |
| 2, 15, and 17 | *barbirostris*, *maculatus*, and *minimus* | 36 | 7 | 43 |
| 3 and 17 | *filipinæ* and *minimus* | 61 | 7 | 68 |
| 3, 15, and 17 | *filipinæ*, *maculatus*, and *minimus* | 17 | 4 | 21 |
| 2, 3, and 17 | *barbirostris*, *filipinæ*, and *minimus* | 44 | 7 | 51 |
| 17 and 24 | *minimus* and *vagus* | 21 | 3 | 24 |
| 2, 17, and 24 | *barbirostris*, *minimus*, and *vagus* | 16 | 3 | 19 |
| 2, 17, and 21 | *barbirostris*, *minimus*, and *subpictus* | 13 | 2 | 15 |

# ILLUSTRATION

## PLATE 1

FIG. 1. Breeding place of *Anopheles minimus* var. *flavirostris* at Baldat, Culion.

2. Breeding place of *Anopheles minimus* var. *flavirostris* at Iwahig, Palawan.

*1*

*2*

PLATE 1.

# THE VITAMIN CONTENT OF PHILIPPINE FOODS, III

## VITAMIN B IN VARIOUS FRUITS AND VEGETABLES

By A. J. HERMANO and GAVINO SEPULVEDA, Jr.
*Of the Bureau of Science, Manila*

ONE PLATE

The American committee on vitamin B nomenclature(1) decided that the antineuritic vitamin should be called vitamin B, and the growth-promoting vitamin should be vitamin G. The two vitamins are fractions of the original vitamin B complex. These vitamins, which are quite different, may be found in the same Philippine fruits and vegetables in varied proportions. Fruits and vegetables are abundantly consumed in the Philippines, but adequate information concerning their vitamin B content is still wanting. People often pay a high price for the extract of rice polishings when this essential factor may be obtained from fruits and vegetables at a low cost. The object of this investigation was to make comparative tests of the vitamin B content of various fruits and vegetables raised in the Philippines. Those that are rich sources of vitamin B tend to make up the deficiency in the Filipino diet which consists mostly of highly polished rice. Since the antineuritic vitamin is essential in maintaining the proper myelinization of the nerves, it is especially important in curing the numerous cases of beriberi which occur annually in the Philippine Islands.

For a little more than two decades, the original vitamin B was regarded as a complex substance, comprising Eijkman's(2) and Funk's(3) antineuritic substance, Goldberger's(4) antipellagric vitamin, and Smith's(5) essential factor in nutrition in addition to the present vitamin B. Since the first publication on the existence of an antineuritic vitamin, many attemps have been made to prepare concentrated products and to isolate this vitamin from rice polishings, yeast, wheat germ, and mongo beans (*Phaseolus aureus*). Many investigators claimed to have produced higher active crystalline substances possessing the properties of vitamin B, and biological tests have been tried on pigeons, bondols, rats, mice, and dogs. The curative effects and maintenance of pigeons and bondols by feeding and by injection of these products, have been shown by Funk,(3) Edie et al.,(6) Suzuki and Odake,(7) Abderhalden and Schaumann,(8) Bowman and Yee,(9) Seidell,(10) Jansen and Donath,(11) Levene,(12) Kinnersley et al.,(13) Guha and Drummond,(14) and Cowgill.(15) The results of these feeding experiments are summarized in Table 1.

## MATERIALS AND EXPERIMENTAL PROCEDURE

Vitamin B appears to be widely distributed in the various tissues and juices of plants, but is more concentrated in the germ and bran as in rice and wheat. The materials used in this investigation consisted of 109 samples of leafy vegetables, flowers, ripe fruits, immature fruits used as vegetables, and underground portions used for food. The samples were purchased mostly in the local markets in Manila, though some were obtained from Baguio in the Mountain Province.

In this investigation six hundred healthy pigeons, weighing from 200 to 320 grams each, were selected for the comparative vitamin tests on various fruits and vegetables. Each cage contained fifteen pigeons (Plate 1, fig. 1). These birds were given plenty of highly polished rice and artesian well water. Each pigeon was also fed daily with about one gram of powdered and dried lean meat (beef) the vitamin B of which had been removed by repeated boiling, washing, and pressing. The feeding was continued and the pigeons were observed daily until each bird developed symptoms of polyneuritis (Plate 1, fig. 2). The sick pigeons were then separated and placed in hospital cages which were protected from flies by very fine wire screens.

During the course of these experiments most of the pigeons were incidentally discovered to be infested with blood-sucking flies, *Pseudolynchia maura*, the transmitting agent of a blood parasite, *Hæmoproteus columbæ*. The infested birds were anæmic and weak and, in some cases, the infestation was so severe as to prove fatal. In this connection, it may be stated that advanced symptoms of hæmoproteiasis columbæ have sometimes been confused with those of polyneuritis columbarum. As a precaution the pigeons were kept in cages which were covered with fine-mesh wire (No. 24) to prevent access of the flies, and the first experiments were repeated.

**TABLE 1.**—*Results obtained by various investigators in feeding or injecting pigeons with prepared products.*

| Investigator. | Dosage of purified products. | Mode of administration. | Remarks. |
|---|---|---|---|
| Funk (3) | From yeast (4 mg) | By injection | Improvement after 3 hours and complete recovery the next day. |
| Edie et al. (6) | From yeast (3 to 6 mg). | Feeding orally | Convulsions controlled in 4 hours and complete recovery in 48 hours. |
| Susuki and Odake (7). | From rice polishings (5 mg). | Feeding by mouth | Gradually improved and cured in 10 days. |
| Abderhalden and Schaumann (8). | From yeast (5 mg) | By injection | Gradually improved and cured and gave protection for 19 days. |
| Bowmann and Yee (9). | From mongo beans (*Phaseolus aureus*) (2 to 3 mg). | do. | Cured within 1 hour. Pigeons moved normally. |
| Seidell (10) | From brewer's yeast (0.100 to 0.200 g) | Fed on alternate days. | Gradually improved and cured in 8 days. |
| Jansen and Donath (11). | From rice polishings ($C_6H_{10}ON_2$) (2 mg). | Feeding orally | Fed to 30 bondols for 15 days; only one contracted polyneuritis. |
| Levene (12) | From brewer's yeast (0.07 to 0.1 mg)[a]. | Fed daily to white rat. | Sufficient to maintain normal growth of rats. |
| Kinnersley et al. (13). | From yeast (0.1 mg) per day. | Feeding by mouth | Curative as pigeon dose. |
| | 1.6 ± 0.4 day dose | Feeding orally | Highest potency administered and cured in 1 day. |
| Guha and Drummond (14). | From wheat embryo (0.005 to 0.015 mg)[a]. | Daily doses | Good growth in rats. |
| Cowgill (15) | From wheat germ (90 to 100 mg). | Feeding orally | Correct daily maintenance dose for birds of 420 and 465 g. |

[a] Products tested on rats.

The effects of deprivation of vitamin B in pigeons, thus producing typical head-stooping polyneuritis, have been shown by Emmett and Peacock,(16) Vedder and Feliciano,(17) McCarrison,(18) Rosedale and Oliveiro,(19) and many others. This method of studying vitamin B deficiency was selected because pigeons are more susceptible to polyneuritis than other laboratory animals and, furthermore, this procedure has been used extensively in determining the value of foods as a source of antineuritic vitamin.

In establishing the curative dose of the fruits and vegetables, polyneuritic pigeons were first numbered and placed in separate cages. The rations used in treating these sick pigeons were as follows:

| Ration— | Fresh fruit or vegetable.<br>g. | Dried lean meat (beef).<br>g. |
|---|---|---|
| A | 0.5 | 1.0 |
| B | 1.0 | 1.0 |
| C | 1.5 | 1.0 |
| D | 2.0 | 1.0 |
| E | 3.0 | 1.0 |
| F | 4.0 | 1.0 |
| G | 5.0 | 1.0 |
| H | 6.0 | 1.0 |
| I | 7.0 | 1.0 |
| J | 8.0 | 1.0 |

A small dosage of the fruit (1 gram) and 1 gram of dried lean meat (ration B) were first given by mouth, as a preliminary test to one beriberi pigeon. If this ration cured we tried three other pigeons as a check. We next tried ration A containing one-half gram of the fruit. Some fruits required other rations (from C to J) containing more than one gram of the fruit. The appropriate dosage that cured the pigeons was reported as the curative amount (Table 5).

Weighed amounts of leafy vegetables, underground portions or immature fruits (used as vegetables) were prepared and cooked with very little water, according to the Filipino method, and then fed to beriberi pigeons as described under fruits. Curative doses were determined and are reported in Tables 2, 3, 4, and 6.

## SUMMARY AND CONCLUSION

Variable amounts of vegetables and fruits were found to cure beriberi pigeons as summarized in Tables 2, 3, 4, 5, and 6.

The vitamin contents of these various fruits and vegetables were recorded as follows:

+++ The fruit or vegetable is an excellent source of vitamin B.
++ The fruit or vegetable is a good source of vitamin B.
+ The fruit or vegetable merely contains vitamin B.
— The fruit or vegetable contains only an appreciable amount of vitamin B.

From the resulting data on leafy vegetables (Table 2), kolitis, alugbati, sili, Indian spinach, prickly-seeded spinach, tamarind shoots, himbaba-o, tango, endive, squash, camote, lettuce, amantec, and laba-laba were found to be excellent sources of vitamin B.

TABLE 2.—*Results of feeding leafy vegetables to polyneuritic pigeons.*

| Names of vegetables. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| | | | g. | |
| *Allaeanthus luzonicus* (Blanco) F.-Vill. | Himbaba-o, karúd, kabág, boñgon, alokón. | Fresh leaves | 2.0 | +++ |
| *Amaranthus viridis* Linn. | Kolites, kulitis, kalúnai, halom. | Fresh leaves and shoots. | 1.0 | +++ |
| *Apium graveolens* Linn | Kinchay, celery | Fresh leaves | 3.0 | ++ |
| *Athyrium esculentum* Copel. | Pako, pakó | do | 4.0 | ++ |
| *Bambusa spinosa* Roxb | Bamboo, kauáyan, baugín, batákan. | Fresh shoot | 3.0 | ++ |
| *Basella rubra* Linn | Alugbáti, libáto, arogbáti, grana. | Fresh leaves and shoots. | 1.0 | +++ |
| *Bauhinia leptopus* Perk. | Kalibangbang, malakmi | Fresh leaves | 4.0 | ++ |
| *Brassica chinensis* Linn. | Pechay, pechai, selgas, messay. | do | 4.0 | ++ |
| *Brassica integrifolia* (West) O. E. Schulz. | Mustard, mostaza | do | 4.0 | ++ |
| *Brassica oleracea* Linn. var. *capitata* Hort. | Cabbage (red), repollo, kobis. | do | 4.0 | ++ |
| *Brassica oleracea* Linn. var. *acephala* DC. | Kolis, kales | do | 5.0 | + |
| *Capsicum frutescens* Linn. | Chili, sili, katumbal, kitikot, chileng-bundok, siling-labúyo. | Fresh leaves and shoots. | 1.0 | +++ |
| *Chrysanthemum coronarium* Linn. | Tañgo, tungháo | do | 2.0 | +++ |
| *Cichorium endivia* Linn | Endive | do | 2.0 | +++ |
| *Colocasia esculentum* (Linn.) Schott. | Gabi, dagmai, abá, gauai | Fresh leaves | 6.0 | + |
| Do | do | Fresh petiole | 5.0 | + |
| *Corchorus olitorius* Linn. | Saluyot, tagabang, pasau | Fresh leaves and shoots. | 3.0 | ++ |
| *Coriandrum sativum* Linn. | Wansoy, culantró, ongsóy, coriander. | Fresh leaves | 5.0 | + |
| *Cucurbita maxima* Duchesne. | Squash, calabáza, kalabása, karabása, kalabasáng-pulá. | Fresh leaves and shoots. | 2.0 | +++ |
| *Helminthostachys zeylanica* (Linn.) Hook. | Túkod-lañgit | do | 4.0 | ++ |
| *Ipomea batatas* (Linn.) Poir. | Camote, tigsi, kamóte | do | 2.0 | +++ |
| *Ipomea reptans* (Linn) | Kankóng, kangkóng, tangkong. | do | 3.0 | ++ |
| *Lactuca sativa* Linn | Lechuga, lettuce | Fresh leaves | 2.0 | +++ |
| *Momordica charantia* Linn. | Amargóso, apaliá, ampalayá, margóso, ampaliá. | Fresh leaves and shoots. | 3.0 | ++ |
| *Moringa oleifera* Lam | Camalungái, balungai, malungái, kalungai, maluñgit. | Fresh leaves | 3.0 | ++ |

TABLE 2.—*Results of feeding leafy vegetables to polyneuritic pigeons*—Continued.

| Names of vegetables. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| | | | *g.* | |
| *Petroselinum hortense* Hoffm. | Beregil, parsley | Fresh leaves | 7.0 | — |
| *Phaseolus calcaratus* Roxb. | Tauhúri, kapilán, anípai | do | 4.0 | ++ |
| *Rumex ambiguus* Gren. | Sorrel spinach, Indian spinach. | Fresh leaves and shoots. | 1.0 | +++ |
| *Spinacia oleracea* Linn. | Prickley-seeded spinach | do | 1.0 | +++ |
| *Solanum nigrum* Linn. | Amantec, kamátes-manók | Fresh leaves | 2.0 | +++ |
| *Tamarindus indica* Linn. | Tamarind, sampáloc, sambag, salomági. | Fresh shoots and tender leaves. | 1.0 | +++ |
| *Tetragonia expansa* Murr. | New Zealand spinach | Fresh leaves and shoots. | 2.0 | +++ |
| (?) | Laba-laba (Algæ) | Fresh sample | 2.0 | +++ |

TABLE 3.—*Results of feeding flowers to polyneuritic pigeons.*

| Names of vegetables. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| | | | *g.* | |
| *Allaeanthus luzonicus* (Blanco) F.-Vill. | Himbaba-o, karúd, kabág, boñgon, alokón. | Fresh flowers | 2.0 | +++ |
| *Brassica oleracea* Linn. var. *botrytis* DC. | Cauliflower | do | 2.0 | +++ |
| *Cucurbita maxima* Duchesne. | Squash, calabasa, karabása, kalabása. | do | 4.0 | ++ |
| *Musa paradisiaca* Linn. var. *compressa* (Blanco) Teodoro. | Pusó, banana | Fresh "puso" | 6.5 | — |
| *Sesbania grandiflora* (Linn.) Pers. | Katúrai, gauai-gáuai, catódaí. | Fresh flowers | 4.0 | ++ |
| *Tamarindus indica* Linn. | Tamarind, sampálok, sambag, salomági. | do | 1.0 | +++ |

Pako, pechay, kinchay, bamboo shoot, alibang-bang, mustard, cabbage, saluyot, wansoy, kangkong, amargoso, camalungai, and tahuri were found to be good sources of vitamin B.

Kolis, gabi leaves and gabi petiole merely contained the vitamin B.

TABLE 4.—*Results of feeding immature fruits used for vegetables to polyneuritic pigeons.*

| Names of vegetables. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| | | | *g.* | |
| *Abelmoschus esculentus* (Linn.) Moench. | Okra | Fresh fruit | 3.0 | ++ |
| *Artocarpus communis* Forst. | Rímas, kamansí, dalangían | Fresh immature fruit. | 4.0 | ++ |
| *Cajanus cajan* (Linn.) Millsp. | Kadiós, kaldis, kardis, kagyús. | Fresh soft seeds | 3.0 | ++ |
| *Canavalia ensiformis* (Linn.) DC. | Jack bean, sitao Americano. | Fresh pods with seeds. | 5.0 | + |
| *Capsicum annuum* Linn | Sweet pepper, silí | Fresh green fruit | 4.0 | ++ |
| *Carica papaya* Linn. | Papáya, kapáya, tapáyas | do | 3.0 | ++ |
| *Cocos nucifera* Linn. | Coconut, niog, lubi, coco, ñgot-ñgot. | Soft fresh meat | 8.0 | — |
| *Cucurbita maxima* Duchesne. | Squash, kalabasang-pulá | Fresh fruit | 4.0 | ++ |
| *Dolichos lablab* Linn. | Bátau, bátao, báglau, parda, búlai. | Fresh pods and seeds. | 2.0 | +++ |
| *Lagenaria leucantha* (Duch.) Rusby. | Upo (Japanese variety) | Fresh fruit | 6.0 | + |
| Do | Upo (long), ópo, kalúbai, tabúñgau. | Fresh green fruit | 3.0 | ++ |
| *Luffa acutangula* (Linn.) Roxb. | Patóla, saykua | Fresh and tender green fruit. | 6.0 | + |
| *Momordica charantia* Linn. | Apaliá, amargóso, ampalayá, margoso, ampaliá. | Fresh immature fruit. | 2.0 | +++ |
| *Pachyrrhizus erosus* (Linn.) Urb. | Sincamás, sinkama, kamás, kikamas, hinkamas. | Fresh green pods with seeds. | 5.0 | + |
| *Phaseolus aureus* Roxb. | Mungo, balátong | Fresh sprouted seeds. | 1.5 | +++ |
| *Phaseolus vulgaris* Linn. | Habichuelas, biríñgi, mula | Fresh pods with seeds. | 5.0 | + |
| *Pisum sativum* Linn. | Sweet peas, chícharo | Fresh green pods with seeds. | 4.0 | ++ |
| *Psophocarpus tetragonolobus* (Linn.) DC. | Winged beans, seguidilla, cigarrillas, kalamismis, segadilla. | Fresh pods with seeds. | 5.0 | + |
| *Sechium edule* Sw. | Chayote | Fresh green fruit | 3.0 | ++ |
| *Solanum melongena* Linn. | Eggplant, talóng, tarong | Fresh immature fruit. | 8.0 | ++ |
| (?) | Bush wax beans | Fresh pods with seeds. | 3.0 | ++ |
| *Vigna sinensis* (Linn.) Savi. | Tagtaga, otóng, cowpeas, batóng, balatong. | do | 3.0 | ++ |
| *Vigna cylindrica* Skeels | String beans, balatong | do | 2.0 | +++ |

TABLE 5.—*Results of feeding ripe fruits to polyneuritic pigeons.*

| Names of fruits. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| | | | *g.* | |
| *Achras zapota* Linn. | Chico, siku | Fresh pulp | 1.0 | +++ |
| *Anacardium occidentale* Linn. | Kasoy, cashew, kachúi, balubad. | do | 1.0 | +++ |
| *Ananas comosus* (Linn.) Merr. | Pineapple, var. smooth Cayenne, piña. | do | 1.0 | +++ |
| *Anona muricata* Linn. | Guayabáno, guanabano, gabáno. | do | 2.0 | +++ |
| *Anona squamosa* Linn. | Atis, sugar-apple, ates | do | 5.0 | + |
| *Artocarpus integra* (Thunb.) Merr. | Jackfruit, lángka, nángka, nanka. | Edible yellow pulp | 4.0 | ++ |
| *Averrhoa carambola* Linn. | Balimbíng, galañgán, daligan. | Fresh pulp without seed. | 5.0 | + |
| *Carica papaya* Linn. | Papáya, kapáya, tapáyas | Fresh pulp | 4.0 | ++ |
| | | | *cc.* | |
| *Citrus aurantium* Linn. | Kagel, kahél, dalandan | Juice of the fresh fruit. | 1.0 | +++ |
| *Citrus maxima* (Burm.) Merr. | Lukbán, suhá, suá | do | 5.0 | + |
| *Citrus mitis* Blanco | Kalamondín, kalamansí, limonsito, kalamunding. | do | 1.0 | +++ |
| | | | *g.* | |
| *Cucumis melo* Linn. | Melón, atimón, katimon | Pulp of the fresh fruit. | 1.0 | +++ |
| *Cyphomandra calycina* Sendt. | Cyndra | Fresh pulp | 7.0 | — |
| *Diospyros discolor* Willd. | Mabolo, kamagóng | do | 4.0 | ++ |
| *Eugenia cumini* (Linn.) Druce. | Dúhat, lombói, lúngboi | Fresh pulp with peeling. | 1.0 | +++ |
| *Eugenia javanica* Lam. | Makópa, yambo | Fresh fruit | 4.0 | ++ |
| *Flacourtia indica* (Burm. f.) Merr. | Serali, bitúñgol | do | 4.0 | ++ |
| *Lansium domesticum* Correa. | Lansones, lanzon | Fresh pulp | 5.0 | + |
| *Lycopersicum esculentum* Mill. | Tomato, kamatis, tomáte | Fresh fruit | 3.0 | ++ |
| *Mangifera indica* Linn. | Mango, mangang-calabao | Fresh pulp | 1.0 | +++ |
| *Mangifera altissima* Blanco. | Pahótan, páho, malapáho | do | 3.0 | ++ |
| *Mangifera indica* Linn. | Mangang-piko | do | 1.0 | +++ |
| *Musa sapientum* Linn. var. *suaveolens* (Blanco) Teodoro. | Buñgulan (banana) | Ripe fruit | 6.0 | + |
| *Musa sapientum* Linn. var. *ternatensis* (Blanco) Teodoro. | Glória (banana) ternáte | do | 8.0 | — |

TABLE 5.—*Results of feeding ripe fruits to polyneuritic pigeons*—Ctd.

| Names of fruits. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| *Musa sapientum* Linn. var. *inarnibal* Teodoro. | Inarnibal (banana) | Ripe fruit | *g.*<br>6.0 | + |
| *Musa sapientum* Linn. var. *lacatan* (Blanco) Teodoro. | Lacatan (banana), lakatán, bañgáran. | do | 6.0 | + |
| *Musa sapientum* Linn. var. *cinerea* (Blanco) Teodoro. | Latundán (banana), letondal; tórdan. | do | 6.0 | + |
| *Musa sapientum* Linn. var. *violacea* (Blanco) Teodoro. | Murado, morado (banana) | do | 6.0 | + |
| *Musa sapientum* Linn. var. *compressa* (Blanco) Teodoro. | Sabá (banana) | do | 7.0 | — |
| *Passiflora edulis* Sims | Pasionária, pasion, maraflora. | Fresh pulp with seeds. | 7.0 | — |
| *Pithecolobium dulce* (Roxb.) Benth. | Kamanchilí, damortis, kamansilí. | Sweet fresh fruit | 3.0 | ++ |
| *Psidium guajava* Linn | Guava, bayábas, bayáuas, guayábas. | Ripe fruit (pink contents). | 4.0 | ++ |
| Do | do | Ripe fruit (white contents). | 4.0 | ++ |
| *Sandoricum koetjape* (Burm. f.) Merr. | Santol, santor | Meat of fresh fruit | 2.0 | +++ |
| Do | do | Pulp of seeds | *cc.*<br>3.0 | ++ |
| *Spondias purpurea* Linn. | Siniguélas, ciruéla, siriguélas, sarguélas. | Pulp of ripe fruit | *g.*<br>3.0 | ++ |

The data in Table 3 show that himbaba-o, cauliflower and tamarin were excellent sources of vitamin B. Squash and katurai were just good sources. Banana (puso) contained no appreciable amount of the vitamin.

The experimental results on immature fruits, reported in Table 4, show that batau, amargoso, mungo, and balatong are excellent sources of antineuritic vitamin.

Okra, kadios, sweet pepper, papaya, squash, upo, sweet peas, chayote, eggplant, bush-wax beans, and cowpeas were good sources of vitamin B.

Sitao (American), upo (Japanese), patola, sincamas, habichuelas, and seguidillas merely contained the antineuritic vitamin. Rimas and immature soft coconut meat contained no appreciable amount of the vitamin B.

As shown by the results reported on Table 5, mango (kalabao and piko), chico, kasoy, pineapple, kagel, kalamondin, melon (Tagalog), duhat, guayabano, and santol (meat) were found to be excellent sources of the antineuritic vitamin.

Tomato, malapaho, kamanchili, santol (pulp), siniguelas, langka, papaya, mabolo, macopa, serali, and guava were found to be good sources of vitamin B.

Atis, balimbing, lukban, lansones, and bananas (buñgulan, inarnibal, lacatan, latundan, and murado) were found to contain antineuritic vitamin. Cyndra and bananas (gloria and sabá) contained no appreciable amount of the vitamin B.

From the experimental results shown in Table 6, labanos was found to be an excellent source of vitamin B. Carrot, ubi, and sincamas were found to be good sources of the antineuritic vitamin. Onion, bauang, gabi (Cebu), tugi, and kamote (white and yellow) were found to contain the vitamin B.

TABLE 6.—*Results of feeding underground portions of plants to polyneuritic pigeons.*

| Names of vegetables. | | Parts used. | Amount used. | Vitamin B ($B_1$). |
|---|---|---|---|---|
| Scientific name. | Common names. | | | |
| | | | *g.* | |
| *Allium cepa* Linn. | Onion (small), sibuyas, lasoná, cebollas. | Fresh rhizomes and leaves. | 5.0 | + |
| *Allium sativum* Linn. | Báuang, garlic, ájos | do. | 5.0 | + |
| *Colocasia esculentum* (Linn.) Schott Melet. | Gabi, (Cebu), dagmái, abá, áua, linsá. | Peeled fleshy root | 6.0 | + |
| *Daucus carota* Linn. | Carrot, zanahoria | Fresh fleshy root | 3.0 | ++ |
| *Dioscorea alata* Linn. | Úbi (purple or violet), kinampái. | do. | 3.5 | ++ |
| *Dioscorea esculenta* (Lour.) Burkill Blanco. | Túgi, toñgo, boga | do. | 6.0 | + |
| *Ipomoea batatas* (Linn.) Poir. | Kamote, tigsi | White peeling, yellow contents fleshy root. | 5.5 | + |
| Do. | do. | Red peeling, white contents fleshy root. | 6.0 | + |
| *Pachyrrhizus erosus* (Linn.) Urb. | Sincamas, kamás, sikamás | Fresh fleshy root | 3.0 | ++ |
| *Raphanus sativus* Linn. | Labanos, radish (Chinese) | do. | 2.0 | +++ |

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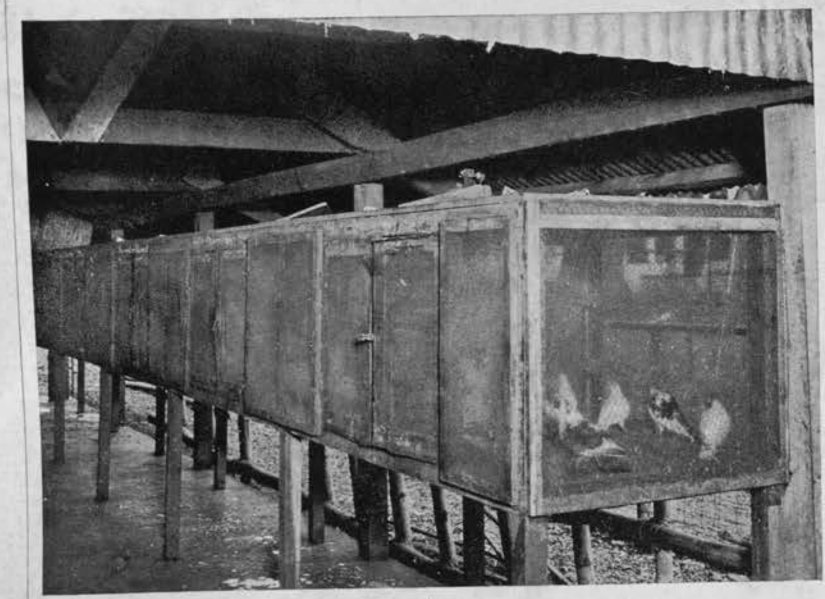
# ILLUSTRATION

## PLATE 1

FIG. 1. Portion of cages.
2. Pigeon ill with polyneuritis.
3. Same pigeon cured after feeding a sample.



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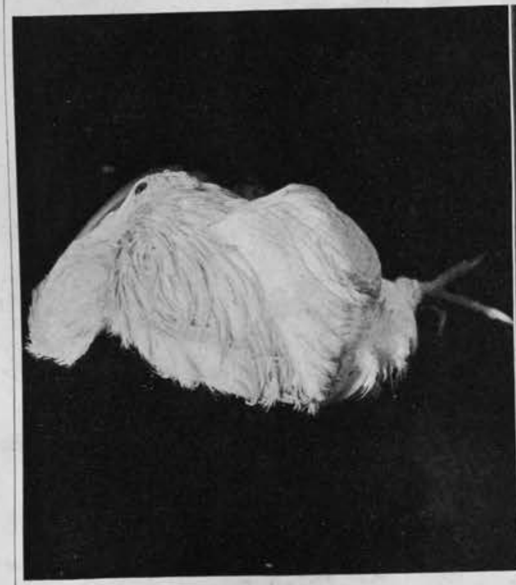

2

3

PLATE 1.

# PHILIPPINE PANAO (DIPTEROCARP) RESIN

By SIMEONA SANTIAGO TANCHICO and AUGUSTUS P. WEST
*Of the Bureau of Science, Manila*
and
J. FONTANOZA[1]
*Late of the Bureau of Forestry, Manila*

THREE PLATES

The dipterocarp, or lauan, is by far the most prominent family of trees in the Philippines. These woods are everywhere utilized for a wider range of uses than those of any other family. The most characteristic feature of these trees is that they contain resin ducts. When the bark and sapwood are cut the oily resin exudes more or less freely and, on exposure to the air, the resin hardens into a sticky, pasty mass.

The dipterocarp family contains several genera, of which the largest is *Dipterocarpus*. The tree known as panao (*Dipterocarpus vernicifluus* Blanco) is one of the important members of this genus.

We have examined the resin which is obtained by cutting the panao tree. When distilled this is separated into an oil which passes over as a distillate and a glassy resin which remains behind as a residue. The constants of both panao oil and resin were determined. The resin seems to be suitable for making a spirit varnish for lamp shades. Probably it could be used for other similar purposes.

An excellent account of Philippine dipterocarp forests is given by Whitford[2] and also by Brown and Mathews.[3]

According to Whitford[4] the dipterocarp forests are of preeminent importance in the Philippines. These forests cover about 75 per cent of the virgin forest area (30,000 square miles) and contain approximately 95 per cent of the standing timber in the Islands. They are found on nearly all types of topography, from immediately behind the frontal zone of the beach to an altitude of approximately 800 meters on the slopes of the largest mountains.

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[1] Mr. Fontanoza was unfortunately taken sick and died about ten months after he collected the samples of resin for this investigation.

[2] The Forests of the Philippines, Bull. P. I. Bur. Forestry 10 (1911).

[3] Philip. Journ. Sci. § A 9 (1914) 413.

[4] The Forests of the Philippines, Bull. P. I. Bur. Forestry 10 (1911) 18 and 60.

Practically all the species of the dipterocarps are large trees, reaching heights of 40 to 50 meters and diameters of 100 to 150 centimeters or more, and it is not rare to find even these dimensions exceeded. They have straight, regular boles and practically all the dipterocarps are evergreens, for the new leaves are formed before the old ones drop.

A detailed description of the wood of panao and other species of the genus *Dipterocarpus* is given by Schneider.[5]

Some years ago the exudations from two species of dipterocarp trees were investigated. Clover[6] and also Bacon[7] examined balao resin from the tree known locally as apitong (*Dipterocarpus grandiflorus*). Balao is used at present for varnishing and caulking native boats. As a varnish it gives a tough and durable coat but has the disadvantage of drying very slowly.

Clover[8] also investigated the resin obtained from the panao tree (*Dipterocarpus vernicifluus*). These resins (balao and panao) appear to have somewhat similar properties. They seem to contain a certain amount of combined water which causes a troublesome frothing when the attempt is made to distil them. They dissolve readily in chloroform and ether but with difficulty in alcohol.

Concerning panao resin Clover states:

> All of the different samples were found to consist of water, sesquiterpene oil, and solids. On subjecting the resin to distillation with a free flame its behavior is similar to that of Balao. A fresh sample from Ambos Camarines gave 25 per cent of water, 35 per cent of oil, and 40 per cent of solid residue. The distillation was discontinued at the point where decomposition became evident. Another sample showed a somewhat different percentage of water and of oil, the difference probably being due to the time and method of collecting.

## EXPERIMENTAL PROCEDURE

The panao trees selected for this investigation were growing in the dipterocarp forest near the town of Hermosa, Bataan Province, Luzon (Plate 1). The exact location where the trees were tapped for resin was near a place called Cocobog in the barrio (district) of Colo (Plate 2). The measurements of these trees are given in Table 1.

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[5] Commercial Woods of the Philippines, Bull. P. I. Bur. Forestry 14 (1916) 163.

[6] Philip. Journ. Sci. 1 (1906) 195.

[7] Philip. Journ. Sci. § A 4 (1909) 121.

[8] Philip. Journ. Sci. 1 (1906) 198.

TABLE 1.—*Measurements of Philippine panao (dipterocarp) trees tapped for panao resin.*

| Tree No. | Diameter. | Thickness of— | | Box. | | | |
|---|---|---|---|---|---|---|---|
| | | Sapwood. | Bark. | Location.[a] | Size. | | |
| | | | | | Height. | Width. | Depth. |
| | *cm.* | *cm.* | *cm.* | | *cm.* | *cm.* | *cm.* |
| 1 | 110.0 | 3.5 | 0.6 | SE | 24.0 | 19.0 | 8.0 |
| 2 | 53.0 | 4.5 | 0.7 | NE | 32.0 | 26.0 | 13.5 |
| 3 | 90.0 | 2.5 | 0.5 | SE | 41.0 | 24.0 | 10.0 |
| 4 | 70.0 | 3.0 | 0.7 | S | 32.0 | 21.0 | 8.0 |
| 5 | 50.0 | 3.5 | 0.6 | NE | 41.0 | 25.0 | 7.0 |
| 6 | 62.0 | 2.5 | 0.5 | S | 44.0 | 20.0 | 7.0 |
| 7 | 100.0 | 3.5 | 0.5 | N | 26.0 | 17.0 | 8.0 |
| 8 | 90.0 | 4.0 | 0.5 | S | 28.0 | 21.0 | 9.0 |
| 9 | 100.0 | 4.0 | 0.4 | W | 32.0 | 25.0 | 6.0 |
| 10 | 92.0 | 5.0 | 0.8 | N | 31.0 | 17.0 | 7.0 |

[a] The letters indicate the side where the tree was boxed, as SE for southeast, N for north, etc.

Experiments carried out by Mr. Fontanoza showed that the highest yields of resin were obtained by boxing the trees. This consists in cutting a cup-shaped cavity in the body of the tree and allowing the resin to exude and collect in it. As shown by the photograph (Plate 3) the exudation comes from the sapwood and not from the bark or heartwood. Some trees were also tapped by means of the cup and gutter system but the yields obtained were rather poor.

The yields of resin obtained and the dates the resin was collected and weighed are given in Table 2.

When the tree was cut the resin flowed rather freely, but the rate of flow gradually decreased and after a few days very little yield was obtained. The resin was then collected and the cut in the tree reopened by chipping. This allowed the resin to exude again for the next collection. No other treatment, such as heating, was applied to the boxes during the collecting period.

In our investigation of panao resin we carried out a number of experiments similar to those reported by Clover and Bacon and obtained about the same results. The crude resin contains some water and also a volatile oil. In separating these constituents from the resin we found it convenient to use the following procedure: The crude resin was dissolved in chloroform and the impurities, such as chips of bark and twigs, removed by filtration. This was a slow and tedious process as the filter paper became clogged with viscous resin and filtration was delayed. This difficulty was overcome by using, as a filter, cotton moistened with chloroform. The filtered solution was distilled at first on a water bath to remove most of the solvent. It was then distilled in vacuo to eliminate the water and volatile oil. The hot residue remaining in the flask was then poured into paper molds. This product, which had a glassy appearance (glassy resin), was powdered and recrystallized repeatedly with methyl alcohol. The purified panao resin is a white powder.

TABLE 2.—*Yield of resin from Philippine panao (dipterocarp) trees.*

| Tree No. | Date tapped. | Resin obtained. | | | | | |
|---|---|---|---|---|---|---|---|
| | | April 25. | April 30. | May 5. | May 16. | May 26. | Total.[a] |
| | 1931 | *g.* | *g.* | *g.* | *g.* | *g.* | *g.* |
| 1 | Apr. 20 | 159.0 | 76.0 | 100.0 | 59.0 | 22.0 | 416.0 |
| 2 | Apr. 20 | 113.0 | 58.0 | 104.0 | 60.0 | 29.0 | 364.0 |
| 3 | Apr. 20 | 91.0 | 58.0 | 82.0 | 36.0 | 20.0 | 287.0 |
| 4 | Apr. 20 | 93.5 | 51.0 | 64.0 | 18.0 | 25.0 | 251.5 |
| 5 | Apr. 20 | 75.5 | 54.0 | 75.0 | 12.0 | 7.0 | 223.5 |
| 6 | Apr. 21 | 96.0 | 57.0 | 95.5 | 60.0 | 42.0 | 350.5 |
| 7 | Apr. 21 | 91.0 | 52.0 | 44.0 | 65.0 | 55.0 | 307.0 |
| 8 | Apr. 21 | 107.0 | 53.0 | 77.5 | 30.0 | 13.0 | 280.5 |
| 9 | Apr. 21 | 92.0 | 57.0 | 87.0 | 37.0 | 24.0 | 297.0 |
| 10 | Apr. 21 | 89.5 | 53.0 | 83.0 | 35.0 | 34.0 | 294.5 |

[a] Grand total, 3,071.50 g; average per tree, 307.15 g.

TABLE 3.—*Constants of panao oil.*

| | |
|---|---|
| Specific gravity ($d\frac{30^\circ}{4^\circ}$ C.) | 0.9143 |
| Optical rotation ($A\frac{30^\circ\text{ C.}}{D}$), 10-cm tube | −11.03 |
| Refractive index ($N\frac{30^\circ\text{ C.}}{D}$) | 1.4696 |
| Acid value (A) | 1.11 |
| Saponification value (B) | 51.29 |
| Ester value (B–A) | 50.18 |

Panao oil, removed from the panao resin by distilling, gave positive tests for double-bond compounds and also for aldehydes as follows:

Decolorized both bromine water and dilute permanganate solution.
Orange color with glacial acetic acid solution of benzidine.
Reduced Fehling's solution giving cuprous oxide precipitate.
Gave positive test with Tollen's reagent.

The constants of panao oil are given in Table 3 and in Table 4 are given the constants of panao resin.

TABLE 4.—*Constants of panao resin.*

| Constants. | Glassy resin (residue from distillation). | Purified resin (white powder).[a] |
|---|---|---|
| Acid value (A) | 21.2 | 32.99 |
| Saponification value (B) | 27.42 | 36.44 |
| Ester value (B—A) | 6.22 | 3.45 |
| Specific rotation $\left(A\frac{30^\circ C.}{D}\right)$, 10-cm tube | +32.6 | +36.41 |
| Specific gravity | 1.075 | ------------ |

[a] Obtained by crystallizing the glassy resin.

Attempts to make a wood varnish with panao resin were not very promising, as the varnish film obtained was not very hard and durable. We made a spirit varnish according to the following proportions:

| | |
|---|---|
| Panao resin, grams | 16 |
| Ethyl alcohol, cubic centimeters | 30 |
| Turpentine, cubic centimeters | 5 |

This preparation appeared to be very suitable for varnishing paper lamp shades and similar fragile articles.

## SUMMARY

The tree known as panao (*Dipterocarpus vernicifluus*) is one of the important members of the genus *Dipterocarpus*. When the bark and sapwood of this tree are cut an oily resin exudes. Ten panao trees were measured and tapped (boxed). The panao resin was collected and weighed. The average yield of resin per tree was 307.15 grams.

Crude panao resin contains some water and also a volatile oil. These were removed by distilling the resin. The constants of panao oil and purified resin were determined.

A spirit varnish suitable for varnishing paper lamp shades and similar fragile articles may be made from panao resin.

# ILLUSTRATIONS

## PLATE 1

The Bataan-Zambales road passing through the dipterocarp forest near Sitio Bulate, Barrio Colo, Hermosa, Bataan Province, Luzon.

## PLATE 2

Location in the forest where tapping experiments for panao resin were conducted. This place was near Sitio Cocobog, Barrio Colo, Hermosa, Bataan Province, Luzon. The panao trees are distinguished by their prominent, straight, white boles.

## PLATE 3

Panao tree No. 2, five days after boxing. The gum exudes from the sapwood (lighter portion of the wood) and not from the bark and heartwood. The box is 32 by 26 by 13.5 centimeters.

PLATE 1.

PLATE 2.

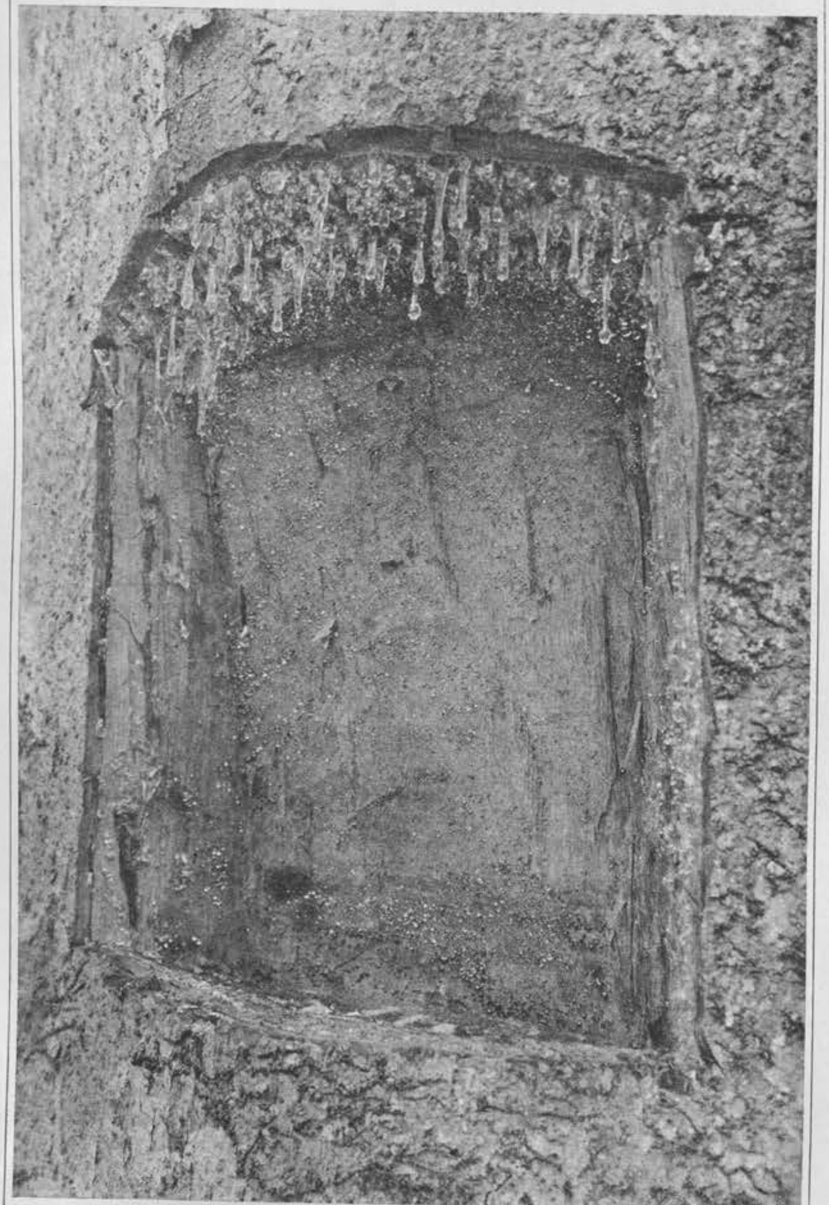

PLATE 3.

# THE LANE-EYNON VOLUMETRIC METHOD FOR THE DETERMINATION OF LACTOSE IN MILK

By F. T. ADRIANO
*Chief, Agricultural Chemistry, Bureau of Plant Industry, Manila*
S. B. OLIVEROS
*Assistant Agricultural Chemist, Bureau of Plant Industry, Manila*
and
L. G. MIRANDA
*Superintendent, San Miguel Brewery, Manila*

Chemical control in factories is always facilitated by methods that are economical in time and labor, easy to follow, and as accurate as the methods in use in technical laboratories. Like other items in the chemical control of a milk plant, the determination of lactose must be rapid and accurate. Lactose is accurately determined through its reducing effect upon copper salts, in which respect it acts like invert sugar. The methylene blue volumetric method for invert sugar has given very satisfactory results in the chemical control in sugar-cane factories, and is now widely used whenever numerous determinations have to be made with a fairly high degree of precision in a short period of time. In the work here reported the volumetric method of Eynon and Lane for determining reducing sugars was compared with three other methods in use: the polariscopic or optical method, the copper-reduction method, and the alkaline potassium permanganate volumetric method reported by Adriano in 1920.

## METHODS

### THE OPTICAL METHOD

The optical method used follows the official method of analysis of the American Association of Official Agricultural Chemists.(1) The specific gravity of the milk sample was obtained by means of a pycnometer at room temperature. A volume of milk based upon twice the normal weight of lactose was measured into a volumetric flask graduated at 102.6 ml. The volume taken, depending upon the specific gravity, was as follows:(1, 4)

TABLE 1.—*Volumes of milk corresponding to double normal weight of lactose.*

| Specific gravity. | Volume. | Specific gravity. | Volume. | Specific gravity. | Volume. |
|---|---|---|---|---|---|
| 1.024 | 64.25 | 1.029 | 63.95 | 1.034 | 63.65 |
| 1.025 | 64.20 | 1.030 | 63.90 | 1.035 | 63.55 |
| 1.026 | 64.15 | 1.031 | 63.80 | 1.036 | 63.50 |
| 1.027 | 64.05 | 1.032 | 63.75 | | |
| 1.028 | 64.00 | 1.033 | 63.70 | | |

To the milk was added 1 ml of an acid mercuric nitrate solution made by dissolving mercury metal in twice its weight of nitric acid and diluting with an equal volume of water. The flask was filled to the mark, shaken, and the contents filtered through a dry filter. The filtrate was polarized in a 400-mm tube. The polariscope reading was divided by 4 to obtain the percentage of lactose in the sample.

### MUNSON-WALKER GRAVIMETRIC METHOD

Twelve and one-half grams of the sample were placed in a 250-ml volumetric flask with 200 ml of water added. To the mixture was added 5 ml of copper sulphate solution containing 69.278 g copper sulphate crystals per liter, and a sufficient quantity of $N/2$ NaOH solution to produce an acid reaction. The flask was filled to the mark, mixed, and the contents filtered through a dry filter.

Twenty-five millimeters of asbestos-filtered copper sulphate solution containing 69.278 g copper sulphate pentahydrate per liter were measured into a 400-ml beaker and 25 ml of an alkaline tartrate solution containing 346 g Rochelle salts and 100 g NaOH per liter were added. Twenty-five millimeters of the clear, protein-free milk sample were added, and the entire volume was made up to 100 ml with water. The beaker was covered with a watch glass and heated over a regulated heater so that the contents began to boil after exactly four minutes. After exactly two minutes boiling, the hot solution was at once filtered through a dry and tared Gooch crucible with an asbestos mat, using suction. The precipitate was washed thoroughly with hot water, then with 10 ml of alcohol and 10 ml of ether. The crucible was dried in an electric oven at 100° C. for thirty minutes and then weighed. From Munson and Walker's tables(1) the weight of lactose was obtained.

### THE ALKALINE POTASSIUM PERMANGANATE METHOD (ADRIANO, 1920)

Twenty-five grams of milk were placed in a 500-ml graduated flask, diluted with 400 ml water and then 10 ml of the copper sulphate solution used in the Munson-Walker method above and a sufficient quantity of $N/2$ NaOH were added, so that the solution remained acid, with copper in solution. The flask was then filled to the mark and shaken, and the contents were filtered through a dry filter. Ten millimeters of the clear solution were used for analysis.

The 10 ml of the filtrate were placed in a 500-ml Erlenmeyer flask, 50 ml of 0.1 $N$ standardized potassium permanganate, 25 ml of a solution of sodium carbonate containing 8.48 g of anhydrous salt per liter, and sufficient water to make 100 ml were added. The flask was heated over a heating device so regulated that the temperature of the contents was raised to 95° C. in two minutes. After two more minutes heating, 25 ml of 30 per cent sulphuric acid were added and, from a burette, 0.1 $N$ standardized oxalic acid was added until the solution was colorless. The excess of the oxalic acid was then titrated with the potassium permanganate solution. The lactose value was taken from the following revised table:(3)

TABLE 2.—*Weight of lactose corresponding to potassium permanganate.*

| Volume 0.1 $N$ $KMnO_4$. | Lactose. | Volume 0.1 $N$ $KMnO_4$. | Lactose. | Volume 0.1 $N$ KMnO4. | Lactose. |
|---|---|---|---|---|---|
| *ml.* | *mg.* | *ml.* | *mg.* | *ml.* | *mg.* |
| 1 | 2.51 | 15 | 17.85 | 28 | 30.60 |
| 2 | 3.21 | 16 | 19.04 | 29 | 31.49 |
| 3 | 4.04 | 17 | 20.16 | 30 | 32.55 |
| 4 | 4.39 | 18 | 20.96 | 31 | 34.65 |
| 5 | 5.47 | 19 | 21.50 | 32 | 35.69 |
| 6 | 6.52 | 20 | 22.89 | 33 | 36.16 |
| 7 | 7.69 | 21 | 23.63 | 34 | 37.26 |
| 8 | 9.13 | 22 | 24.87 | 35 | 38.26 |
| 9 | 9.98 | 23 | 25.92 | 36 | 38.64 |
| 10 | 11.37 | 24 | 26.67 | 37 | 39.28 |
| 11 | 12.30 | 25 | 28.10 | 38 | 40.16 |
| 12 | 13.80 | 26 | 28.39 | 39 | 40.56 |
| 13 | 15.41 | 27 | 29.50 | 40 | 41.47 |
| 14 | 16.72 | | | | |

### LANE-EYNON METHYLENE BLUE METHOD

This method is given in the Official Methods,(1) in the Hawaiian Methods,(2) and discussed by Lane and Eynon.(5) The reagents used were: (1) One per cent aqueous solution of methylene blue, specified for indicator use; (2) Soxhlet's modification of Fehling's solution; (*a*) 69.278 g chemically pure copper sulphate crystals per liter, filtered through asbestos, and (*b*) alkaline tartrate consisting of 346 g Rochelle salts and 100 g chemically pure sodium hydroxide per liter, filtered through asbestos; (3) clarifying solution: 54 Brix normal (neutral) lead acetate, and for deleading, a solution of 30 g potassium oxalate and 70 g disodium phosphate separately dissolved per liter. For standardizing the copper sulphate solution, a standard invert sugar solution was made as follows: 9.5000 g pure sucrose were weighed, 5 ml concentrated HCl added and made up to about 100 ml. The solution was allowed to stand three days, then made up to 1 liter in a glass-stoppered volumetric flask. For use, 50 ml of this solution was measured in a 250-ml flask, neutralized with sodium carbonate, and made up to the mark. One hundred ml of this solution contained 0.02 g invert sugar. The copper sulphate solution was standardized as if analyzing this invert sugar solution, and readjusted so that exactly 25.64 ml of the standard invert sugar solution will require 10 ml of the Fehling's solution. In the table for invert sugar, 25.64 ml of invert sugar solution are set equivalent to 200 mg invert sugar or 270.91 mg hydrated lactose, $Cl_2H_{22}O_{11}.H_2O$.

Twenty-five grams of milk were diluted in a 500-ml flask with about 400 ml water. The neutral lead acetate solution was added avoiding any excess, shaken, and the mixture deleaded by adding the phosphate-oxalate mixture until no further precipitation occurred. The mixture was made up to the mark, and filtered through a dry filter.

Five millimeters of each of the copper sulphate and alkaline tartrate solutions were measured from 5-ml graduated burettes into a 250-ml Erlenmeyer flask. Twenty millimeters of the clear milk sample were added from a graduated burette and the flask heated to boiling over a wire gauze. About fifteen seconds after boiling, more of the sample was added until only the faintest perceptible blue color remained. Three drops of the methylene blue indicator were added, then the titration was completed by adding more of the milk sample dropwise. The end point, accurate to one drop of titre, was reckoned when the blue color was discharged.

For precise titrations, to the reagents in the flask was added cold the milk sample up to 0.5 to 0.8 ml of the total volume required in the first or incremental titration. The mixture was then boiled for two minutes, after which time three drops of the indicator were added, and the titration was completed within the next minute. From the quantity of the titre used, the lactose was calculated from Table 3, also given in the Official Methods(1) and by Lane and Eynon.(5)

TABLE 3.—*Lactose table for the methylene blue method.*

| Volume of sugar solution required. | For 10 ml Fehling's solution hydrated lactose $C_{11}H_{22}O_{11} \cdot H_2O$. | | Volume of sugar solution required. | For 10 ml Fehling's solution hydrated lactose $C_{11}H_{22}O_{11} \cdot H_2O$. | |
|---|---|---|---|---|---|
| *ml.* | *Mg lactose.* | *Mg per 100 ml.* | *ml.* | *Mg lactose.* | *Mg per 100 ml.* |
| 15 | 68.3 | 455.0 | 33 | 67.8 | 205.6 |
| 16 | 68.2 | 426.0 | 34 | 67.9 | 199.7 |
| 17 | 68.2 | 401.0 | 35 | 67.9 | 194.0 |
| 18 | 68.1 | 378.0 | 36 | 67.9 | 188.6 |
| 19 | 68.1 | 358.0 | 37 | 67.9 | 183.5 |
| 20 | 68.0 | 340.0 | 38 | 67.9 | 178.7 |
| 21 | 68.0 | 323.8 | 39 | 67.9 | 174.1 |
| 22 | 68.0 | 309.1 | 40 | 67.9 | 169.7 |
| 23 | 67.9 | 295.4 | 41 | 68.0 | 165.9 |
| 24 | 67.9 | 282.9 | 42 | 68.0 | 161.9 |
| 25 | 67.9 | 271.6 | 43 | 68.0 | 158.1 |
| 26 | 67.9 | 261.0 | 44 | 68.0 | 154.7 |
| 27 | 67.8 | 251.1 | 45 | 68.1 | 151.3 |
| 28 | 67.8 | 242.1 | 46 | 68.1 | 148.0 |
| 29 | 67.8 | 233.8 | 47 | 68.2 | 145.1 |
| 30 | 67.8 | 226.0 | 48 | 68.2 | 142.1 |
| 31 | 67.8 | 218.7 | 49 | 68.2 | 139.2 |
| 32 | 67.8 | 211.9 | 50 | 68.3 | 136.6 |

## RESULTS

The results of the comparative study of the four methods of determining lactose in milk are given in Table 4.

## DISCUSSION OF RESULTS

Table 4, giving a comparison of the percentage of lactose in milk samples as determined by four methods, shows that the maximum deviation of lactose percentage given by the methylene blue method from that given by the gravimetric method does not go beyond 0.1 per cent difference. From the point of view of precision, therefore, the methylene blue method is satisfactory. The optical method apparently gives erratic results, the difference in percentage of lactose from that determined by the gravimetric method coming to as high as 0.53 per cent. Better results could be obtained by the optical method following the double-dilution method given by Sherman,(6) but this procedure entails too much time to be satisfactorily employed in factory-control work, although the single-dilution method is rapid.

TABLE 4.—*Comparison of four methods of lactose determination.*

| Sample. | Method. | | | |
|---|---|---|---|---|
| | Gravimetric. | Optical. | Adriano. | Lane-Eynon. |
| Evaporated canned, diluted 1 : 1 | 4.799 | 4.82 | 4.736 | 4.732 |
| | 4.856 | 4.83 | 4.922 | 4.746 |
| | 4.828 | 4.83 | 4.829 | 4.739 |
| Fresh carabao milk | 4.716 | 4.83 | 4.755 | 4.644 |
| | 4.621 | 4.83 | 4.683 | 4.628 |
| | 4.669 | 4.83 | 4.719 | 4.636 |
| Do | 4.586 | 4.85 | 4.815 | 4.630 |
| | 4.578 | 4.83 | 4.646 | 4.531 |
| | 4.582 | 4.84 | 4.731 | 4.581 |
| Reconstituted milk | 4.955 | 4.82 | 4.851 | 4.560 |
| | 4.950 | 4.81 | 4.872 | 4.870 |
| | 4.953 | 4.82 | 4.862 | 4.865 |
| Natural sterilized milk | 4.944 | 4.42 | 4.894 | 4.812 |
| | 4.940 | 4.40 | 4.925 | 4.872 |
| | 4.942 | 4.41 | 4.910 | 4.842 |
| Evaporated canned, diluted 1 : 1 | 4.689 | 4.78 | 4.547 | 4.784 |
| | ---------- | 4.76 | 4.584 | 4.746 |
| | 4.689 | 4.77 | 4.566 | 4.765 |
| Do | 4.941 | ---------- | 4.572 | 4.806 |
| | 4.810 | ---------- | 4.524 | 4.737 |
| | 4.876 | ---------- | 4.548 | 4.772 |

The official gravimetric method is held to be the most accurate, if the milk samples are properly clarified. The objection to the use of this method is the number of weighings with the analytical balance that has to be made in the analysis. The method developed by the senior author(3) is also fast and accurate, but requires the handling of several burettes, and takes more time than the Lane-Eynon method. The latter after a few trials gives satisfactory results that can be easily duplicated. Trials have been made using unclarified milk with the methylene blue method. These trials gave an average difference of about 7 mg lactose per 100 ml of solution, the unclarified sample giving a higher percentage of lactose. When it is necessary to secure rapidity even at the expense of accuracy, or when comparisons of the same kind of products are to be made, clarification of the milk sample can be dispensed with.

## SUMMARY

A comparison of four methods of determining lactose in milk—by the the Munson-Walker gravimetric method, optical method, alkaline potassium permanganate method, and volu-

metric methylene blue method—has shown that the volumetric methylene blue method can be used for this purpose with very satisfactory results in point of rapidity, convenience, and accuracy.

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# MUTILLIDÆ OF THE PHILIPPINE ISLANDS[1]

By CLARENCE E. MICKEL

*Of the University of Minnesota*

ONE PLATE

Some ten years ago the late Prof. C. F. Baker, then dean of the College of Agriculture, Los Baños, Philippine Islands, sent a large number of specimens of Mutillidæ to the United States National Museum for identification. The material was sent to me at that time for study. Later I received several sendings of specimens direct from Professor Baker, and when the United States National Museum acquired Professor Baker's collections after his death a final lot of material was sent me. A preliminary survey of the first sendings revealed that the Philippine mutillid fauna was much greater than anyone had supposed. It was also apparent from this first brief study that considerable confusion existed in the records of Mutillidæ from the islands in the Pacific Ocean and that further confusion could only be avoided by a study of the type material of species known from that general region. The study then lay dormant for several years due to the fact that nearly all the type specimens were in the collections of European museums, which necessitated a period of study abroad. In 1930, the John Simon Guggenheim Memorial Foundation, by means of a fellowship, made it possible for me to spend a year in Europe studying mutillid type material. A part of this time was devoted to the study of the mutillids described from all of the islands of the Pacific Ocean. A paper has already been published giving the results with respect to the fauna of Formosa. The present paper deals only with the mutillid fauna of the Philippine Islands. A third, in preparation, treats of all the species known from the islands of the Pacific Ocean, including Formosa and the Philippines. In addition to the Baker collection I have been privileged to study material from the collections of the Philippine Bureau of Science, the Research Bureau of the Philippine Sugar Association, the Experiment Station of the Hawaiian Sugar Planters' Association, and Cornell University, Ithaca, New York.

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Robert Brown (1906) published a catalogue of the Hymenoptera described or recorded from the Philippine Islands in which thirteen species of Mutillidæ were listed. Since that date the species *browni* Rohwer and *itambusa* Cockerell have been described, and *vicina* Sichel and Radoskowski, *nigra* Smith, and *ianthea* Smith have been added to Brown's list. The status of the species described with type localities in the Philippine Islands is as follows: The first species of Mutillidæ recorded from the Philippine Islands was the female sex of *Timulla* (*Trogaspidia*) *philippinensis*, described by Frederick Smith in 1855. The male of this species was described as *Trogaspidia bicolor* by Ashmead, 1905. *Timulla accedens*, described in 1869 by Sichel and Radoskowski, is a synonym of *philippinensis*. A second species, *luzonica*, was described by Radoskowski in 1885. Ashmead described two additional species, *semperi* in 1904 and *minor* in 1905, and Brown described *manilensis* and *parva* in 1906. *Timulla browni*, described by Rohwer in 1910, is a synonym, the female sex of *minor*. The holotype of *Trogaspidia itambusa* Cockerell has been examined and found to be a subspecies of *philippinensis* Smith. Thus seven valid species and subspecies have been previously described with type localities in the Philippine Islands.

The eight additional species, with type localities elsewhere than the Philippines, may be disposed of as follows: *Mutilla maculofasciata* Saussure was described in 1867 with type localities Ceylon, Timor, and Luzon. The Ceylon specimen is available in Vienna, Austria, and has been examined. Nothing like it is known from the Philippines. I have been unable to locate the Luzon or Timor specimens in any of the European collections and cannot say what they may have been. Even though Saussure's Luzon specimen of *maculofasciata* cannot be identified, the species can be eliminated from the Philippine list since it is certain the Luzon specimen was not the same as the Ceylon species. The specimen from Luzon recorded by Sichel and Radoskowski in 1869 as *analis* Lepeletier has been examined and found to be a specimen of *minor* subsp. *minor* Ashmead. *Mutilla analis* Lepeletier from India is an entirely different species. The specimen from Luzon recorded by Sichel and Radoskowski in the same work as *dimidiata* Lepeletier is not available for examination, but the information given by the authors leaves no doubt that the specimen was a male of *philippinensis* Smith. The type of *dimidiata* Lepeletier has been examined and it is certain that this species is not known from the Philippine Islands. The type locality of *vicina* Sichel and Radoskowski, 1869, is given as Amboina and Luzon. The specimen from Luzon was examined and found to be a female of *minor* subsp. *minor* Ashmead. I consider the Amboina specimen the lectotype of *vicina*. The species recorded as *nigra* Smith by Bingham in 1895 has been examined and found to be an example of *Smicromyrme viriata* subsp. *nitela* subsp. nov., described hereafter. The specimens that Bingham recorded as *suspiciosa* Smith in the same paper proved to be a composite series of *Timulla (Trogaspidia) philippinensis, T. (T.) minor* subsp. *whiteheadi, T. (T.) depressula,* and *T. (T.) eremita* subsp. *umbra*. None of the specimens was the same as *suspiciosa* Smith, the type of which was examined. André in 1903 recorded *Mutilla discreta* Cameron from the Philippines. I have not been able to examine André's specimen to determine its identity, but it is certainly not *discreta* Cameron. That species should be eliminated from the Philippine list. The specimen recorded by Zavattari, 1913, as *ianthea* Smith is probably a female specimen of *philippinensis* Smith.

This analysis shows that eighteen species have been described or recorded from the Philippines, thirteen of them having been listed in Brown's catalogue. Ten of these were originally described from the Philippine Islands. Eight are species described from other localities, and as indicated above all are to be rejected as non-Philippine species. Of the ten originally described from the Philippines three fall as synonyms. Therefore, seven species are definitely known from the Philippine Islands. In the following pages forty-eight species and twenty-one subspecies are discussed. These are distributed among the following genera: *Squamulotilla,* seventeen species, one subspecies; *Odontomutilla,* three species; *Timulla (Trogaspidia),* fifteen species, fourteen subspecies; and *Smicromyrme,* thirteen species, six subspecies. Fifty-six of these species and subspecies are new, thirteen having previously been described.

The host relations of the Philippine species may be briefly summarized as follows: F. X. Williams (1919) has reared a female, which is undoubtedly *Timulla (T.) minor* subsp. *minor* (Ashmead), from the cocoons of *Tiphia lucida* Ashmead. He also succeeded in getting the females of this mutillid to oviposit in cocoons of *Tiphia lucida* and in rearing the larvæ to maturity. A. W. Lopez (1931) reports a male mutillid wasp as having been reared from a scoliid wasp cocoon. I have examined this male and find it to be *T.* (*T.*) *minor* subsp. *visayensis* subsp. nov.

Six hundred fifty-four of the twenty-one hundred specimens studied—that is, almost one-third—were found to be examples of *T.* (*T.*) *minor* (Ashmead). These specimens were from localities widely distributed throughout the Islands and were not a homogeneous lot. They were clearly a mixed group. A study of the genitalia of the male specimens showed that six different forms of genitalia were present. The specimens were then arranged according to the different forms of male genitalia, and it was found that each form of male genitalia was limited to specimens from a definite geographic area. These areas were as follows: (*a*) The extreme northern part of Luzon Island (Cape Engaño); (*b*) Tayabas Province, including Polillo Island; (*c*) all of Luzon north and west of Tayabas Province, with the above exceptions; (*d*) Luzon Island south and east of Tayabas Province, and Samar, Biliran, Leyte, Bohol, Mindanao, and Basilan Islands; (*e*) Sibuyan, Batbatan, Panay, Negros, and Cebu Islands; and (*f*) Palawan Island. For the purposes of discussion I have named these areas, respectively, (*a*) northern Luzon, (*b*) Tayabas, (*c*) western Luzon, (*d*) Mindanao, (*e*) Visayas, and (*f*) Palawan. The males of *minor* from each of these six areas have a distinct form of male genitalia, although the general type of male genitalia is the same in all six and the external characters by which they may be separated are not very clear-cut. The females from western Luzon are easily separated from all the rest, but those from Tayabas, Visayas, and Mindanao are inseparable by morphological criteria; female specimens were not seen from northern Luzon and Palawan. I have, therefore, chosen to rank these six forms of *minor* as subspecies, each of which appears to inhabit an isolated geographic area.

It is interesting to note that the geographic areas defined on the basis of subspecific geographic distribution in the species *minor* appear to have validity with respect to all the Mutillidæ from the Philippine Islands. There are exceptions, but of the sixty-nine species and subspecies treated in this paper, forty-eight, or slightly over two-thirds, are limited in their distribution to a single one of these areas. The following table shows the distribution of the sixty-nine species of Mutillidæ in these six geographic areas.

*Distribution of Mutillidæ in six geographic areas of the Philippines.*

| | (*a*) Northern Luzon. | (*b*) Tayabas. | (*c*) Western Luzon. | (*d*) Visayas. | (*e*) Mindanao. | (*f*) Palawan. |
|---|---|---|---|---|---|---|
| *Squamulotilla:* | | | | | | |
| *byblis* | ------ | ------ | × | × | ------ | ------ |
| *subtriangularis* | ------ | ------ | ------ | ------ | × | ------ |
| *galatea* | ------ | ------ | × | ------ | ------ | ------ |
| *deserta* | ------ | ------ | × | ------ | ------ | ------ |
| *oblectabilis* | ------ | ------ | × | ------ | ------ | ------ |
| *fucosa* | ------ | ------ | ------ | ------ | × | ------ |
| *ocypote* | ------ | × | ------ | ------ | ------ | ------ |
| *dictynna* | ------ | ------ | ------ | ------ | × | ------ |
| *imparilis* | ------ | ------ | × | ------ | ------ | ------ |
| *disjuncta* | ------ | ------ | × | ------ | ------ | ------ |
| *concava* | ------ | ------ | ------ | ------ | × | ------ |
| *roxane* | ------ | ------ | ------ | × | ------ | ------ |
| *subdebilis* | ------ | ------ | × | ------ | ------ | ------ |
| *sulpicilla* | ------ | ------ | ------ | ------ | × | ------ |
| *teuta* subsp. *teuta* | ------ | ------ | × | ------ | ------ | ------ |
| *teuta* subsp. *vicinaria* | ------ | ------ | ------ | × | ------ | ------ |
| *eminula* | ------ | ------ | × | ------ | ------ | ------ |
| *umbrosa* | ------ | ------ | × | ------ | ------ | ------ |
| *Odontomutilla:* | | | | | | |
| *familiaris* | ------ | ------ | × | × | × | ------ |
| *pedaria* | ------ | ------ | ------ | ------ | × | × |
| *andromeda* | ------ | ------ | × | × | × | ------ |
| *Timulla (Trogaspidia):* | | | | | | |
| *philippinensis* subsp. *philippinensis* | × | × | × | × | × | × |
| *philippinensis* subsp. *williamsi* | ------ | ------ | × | ------ | ------ | ------ |
| *philippinensis* subsp. *itambusa* | ------ | × | ------ | ------ | ------ | ------ |
| *minor* subsp. *minor* | ------ | ------ | × | ------ | ------ | ------ |
| *minor* subsp. *whiteheadi* | × | ------ | ------ | ------ | ------ | ------ |
| *minor* subsp. *tayabasensis* | ------ | × | ------ | ------ | ------ | ------ |
| *minor* subsp. *visayensis* | ------ | ------ | ------ | × | ------ | ------ |
| *minor* subsp. *islandica* | ------ | ------ | ------ | ------ | × | ------ |
| *minor* subsp. *princesa* | ------ | ------ | ------ | ------ | ------ | × |
| *eremita* subsp. *eremita* | ------ | × | × | × | × | ------ |
| *eremita* subsp. *umbra* | ------ | ------ | × | ------ | ------ | ------ |
| *luzonica* subsp. *luzonica* | ------ | ------ | × | ------ | ------ | ------ |
| *luzonica* subsp. *panayensis* | ------ | ------ | ------ | × | ------ | ------ |
| *ovatula* subsp. *ovatula* | ------ | ------ | ------ | × | ------ | ------ |
| *ovatula* subsp. *aurifera* | ------ | ------ | × | ------ | ------ | ------ |
| *depressula* | × | ------ | × | ------ | ------ | ------ |
| *bakeri* | ------ | ------ | ------ | ------ | × | ------ |
| *tegularia* | ------ | ------ | × | × | × | ------ |
| *tethys* | ------ | ------ | ------ | ------ | ------ | × |
| *manilensis* | × | ------ | × | × | × | × |
| *proserpina* subsp. *proserpina* | ------ | ------ | ------ | × | × | ------ |
| *proserpina* subsp. *tibiata* | ------ | ------ | × | ------ | × | ------ |
| *proserpina* subsp. *sibuyanensis* | ------ | ------ | ------ | × | ------ | ------ |
| *ira* subsp. *palawana* | ------ | ------ | ------ | ------ | ------ | × |
| *temeraria* | ------ | ------ | × | ------ | ------ | ------ |
| *fortuita* | ------ | ------ | ------ | × | × | × |
| *nigerrima* | ------ | × | ------ | ------ | × | ------ |
| *sticticornis* subsp. *sticticornis* | ------ | ------ | ------ | ------ | × | ------ |
| *sticticornis* subsp. *nigridia* | ------ | ------ | ------ | ------ | × | ------ |

*Distribution of Mutillidæ in six geographic areas of the Philippines*—Ctd.

| | (a) Northern Luzon. | (b) Tayabas. | (c) Western Luzon. | (d) Visayas. | (e) Mindanao. | (f) Palawan. |
|---|---|---|---|---|---|---|
| *Smicromyrme:* | | | | | | |
| *ilerda* subsp. *sparsilis* | ------ | ------ | ------ | ------ | × | ------ |
| *hyale* | ------ | ------ | ------ | ------ | × | ------ |
| *viriata* subsp. *viriata* | ------ | ------ | × | × | × | ------ |
| *viriata* subsp. *nitela* | ------ | ------ | × | × | × | ------ |
| *fura* subsp. *fura* | ------ | ------ | × | × | × | ------ |
| *fura* subsp. *anthracipes* | ------ | ------ | × | ------ | ------ | ------ |
| *caerulea* | ------ | ------ | ------ | ------ | × | ------ |
| *basalis* subsp. *basalis* | ------ | ------ | ------ | ------ | × | ------ |
| *basalis* subsp. *annularis* | ------ | ------ | × | ------ | ------ | ------ |
| *parva* | ------ | ------ | × | ------ | × | ------ |
| *fluctuata* | ------ | ------ | ------ | × | × | ------ |
| *zebina* | ------ | ------ | × | ------ | × | ------ |
| *palawanensis* | ------ | ------ | ------ | ------ | ------ | × |
| *autonoe* | ------ | ------ | ------ | ------ | ------ | × |
| *semperi* subsp. *semperi* | ------ | × | × | × | ------ | ------ |
| *semperi* subsp. *nigrogastra* | ------ | ------ | × | ------ | ------ | ------ |
| *bakeri* | ------ | ------ | ------ | ------ | ------ | × |
| *lavinia* subsp. *lavinia* | ------ | ------ | × | ------ | × | ------ |
| *lavinia* subsp. *atrata* | ------ | ------ | ------ | ------ | × | ------ |

An analysis of the information in the above table shows the following:

Six species are found in the Philippine Islands which are also known from localities without, thus:

- One species occurs in western Luzon, the Visayas, and Mindanao of the Philippines, as well as in Borneo and the Malay Peninsula (there may be some doubt about the latter locality).
- One species occurs in western Luzon and Mindanao, as well as in Borneo.
- One species occurs in the Visayas and Mindanao, as well as in Borneo.
- One species occurs in the Visayas and Mindanao, as well as in Morty Islands.
- One species occurs in Mindanao, as well as in Bachian.
- One species occurs in western Luzon, as well as in Celebes.

Only one species or subspecies occurs in all six of the Philippine areas.

A second species occurs in five of the areas and is absent from northern Luzon.

A third species occurs in four of the areas and is absent from northern Luzon and Palawan.

Seven species and subspecies occur in only three of the areas:

- Five of these are found in western Luzon, the Visayas, and Mindanao.
- One occurs in western Luzon, Tayabas, and the Visayas.
- One occurs in the Visayas, Mindanao, and Palawan.

Seven species and subspecies occur in only two of the areas:
  One is found in northern Luzon and western Luzon.
  One is found in western Luzon and the Visayas.
  Three occur in western Luzon and Mindanao.
  One occurs in Tayabas and Mindanao.
  One is found in Mindanao and Palawan.
One subspecies occurs only in the northern Luzon area.
Three species and subspecies occur only in the Tayabas area.
Seventeen species and subspecies occur only in the western Luzon area.
Six species and subspecies occur only in the Visayas area.
Thirteen species and subspecies occur only in the Mindanao area.
Six species and subspecies occur only in the Palawan area.

At least one generalization may be drawn from the above data; namely, the Mutillidæ of the Philippine Islands are, in general, local in their distribution; in most cases, a species or a subspecies is restricted to a small geographic area; the cases of wide geographic distribution are comparatively rare. A preliminary survey leads me to believe that this generalization is true regarding the Mutillidæ in all parts of the world. The fact that the opposite view has been held by some of the earlier students of Mutillidæ has led to vast confusion in the identification and records of species and subspecies.

In the case of previously described species recorded herein, the type of each species has been examined and Philippine material compared with it to verify the determinations. All of the specimens have been examined, studied, or described with the aid of a wide-field binocular microscope at a magnification of 27.5 diameters. Every specimen studied bears a label giving my specific determination of that specimen. The genitalia of male specimens have been studied for all species of which the male sex is represented. In most instances the genitalia as removed from the tip of the abdomen have been mounted on a paper point and placed on the pin beneath the specimen. In a few cases it has been found advantageous to dissect the genitalia apart and to make permanent slide mounts. In all cases where the male genitalia are a necessary aid to identification they are figured. The figures are composite due to the fact that all views could not be made from a slide mount; therefore, the latter, and a second partially dissected specimen mounted on a paper point, have been used in making the drawings. Allowance must be made, when using the figures as criteria for identification, for the position of the genitalia when they are examined; a slight rotation of the genitalia to the right or left, or to the front and back makes a striking change in the appearance of the same specimen. All such factors have been taken into account in the present study.

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### *Key to the Philippine genera of Mutillidæ.*

#### MALES

1. Tegulæ small, scalelike, convex, smooth and shining, the hind margin not reflexed; mandibles beneath unarmed; tergites 3 to 7 with a distinct, median, longitudinal carina.................... *Squamulotilla* Bischoff.

Tegulæ distinctly larger, the hind margin distinctly reflexed; or, if not, the latter coarsely sculptured; mandibles beneath armed or not; tergites 3 to 7 without a median carina........................................................ 2.

2. First abdominal segment broad and transverse; posterolateral angles of scutellum produced, thus more or less dentate.
*Odontomutilla* Ashmead.

First abdominal segment of rather slender form, sessile but never strongly, transversely developed; posterolateral angles of scutellum not produced .................................................................................... 3.

3. Vertex not at all elevated posteriorly, not flattened, rounded throughout, the posterior margin not truncate, punctate throughout without any trace of striæ; distance between origin of vein M on vein R and the base of the stigmatic cell scarcely greater than the length of the latter ................................................ *Timulla* (*Trogaspidia*) Ashmead.

Vertex elevated posteriorly, more or less flattened, truncate posteriorly at the middle, distinctly longitudinally striate-punctate throughout; distance between origin of vein M on vein R and the base of the stigmatic cell equal to twice the length of the latter.
*Smicromyrme* Thomson.

FEMALES

1. Mesopleuræ with a very prominent, vertical, lamelliform projection just above the middle coxæ .......... *Squamulotilla* Bischoff.
   Mesopleuræ without such a vertical, lamelliform projection .......... 2.
2. First abdominal segment strongly transverse, short, sharply truncate anteriorly, presenting a broad, anterior surface at right angles to the abdomen; thorax more or less hexagonal, the sides converging anteriorly and posteriorly .......... *Odontomutilla* Ashmead.
   First abdominal segment sessile, but not strongly transverse, not sharply truncate anteriorly; thorax rectangular, the sides approximately parallel .......... 3.
3. Second abdominal tergite ornamented with a pair of pale pubescent spots .......... *Timulla* (*Trogaspidia*) Ashmead.
   Second abdominal tergite either without spots, or with unpaired, pale pubescent spots, sometimes only one, sometimes three.
   *Smicromyrme* Thomson.

## Genus SQUAMULOTILLA Bischoff

*Key to the species.*

MALES

1. Wings with only one cubital cell, $R_5$ and $R_4$ absent .......... 2.
   Wings with two cubital cells, only $R_4$ absent .......... 5.
2. Lateral margins of pronotum with a small, median tubercle; second tergite with moderate, distinct punctures, for the most part separated by their own diameter .......... *ocypote* sp. nov.
   Lateral margins of pronotum not tuberculate medially; second tergite usually more sparsely punctate, the punctures separated by from one to three times their own diameter .......... 3.
3. Lateral margins of pronotum straight, not at all sinuate; punctures of second abdominal tergite separated by about three times their own diameter .......... *dictynna* sp. nov.
   Pronotum narrowed anteriorly, the lateral margins not forming a straight line but more or less sinuate; punctures of second abdominal tergite for the most part separated by one to two times their own diameter .......... 4.
4. Sides of propodeum with small, distinct punctures; second abdominal tergite with small punctures separated by one to two times their own diameter .......... *imparilis* sp. nov.
   Sides of propodeum distinctly reticulate; second abdominal tergite with fine punctures separated by two to three times their own diameter.
   *disjuncta* sp. nov.
5. Entirely black or dark metallic blue .......... 6.
   At least the thorax more or less ferruginous .......... 9.
6. Second abdominal sternite conspicuously concave, glabrous.
   *concava* sp. nov.
   Second abdominal sternite convex, not at all concave .......... 7.
7. First abdominal sternite with a distinct, well-developed, median, longitudinal carina; lateral margins of pronotum, each with a distinct, median tubercle .......... *umbrosa* sp. nov.

First abdominal sternite without a median, longitudinal carina; lateral margins of pronotum very slightly angulate medially but without a distinct, median tubercle .......... 8.

8. Hypopygium with a conspicuous, transverse, arcuate carina at its proximal margin; length, 9 millimeters .......... *roxane* sp. nov.

Hypopygium with a very feeble, transverse, arcuate carina at its proximal margin; length, 5 millimeters .......... *subdebilis* sp. nov.

9. First abdominal sternite with a distinct, well-developed, median, longitudinal carina .......... *eminula* sp. nov.

First abdominal sternite without a median, longitudinal carina .......... 10.

10. Hypopygium with a conspicuous, transverse, arcuate carina at the proximal margin; thorax more or less ferruginous, but at least the tegulæ very dark brown to black .......... 11.

Hypopygium with only a feeble, transverse carina at the proximal margin; thorax including the tegulæ entirely pale ferruginous.
*sulpicilla* sp. nov.

11. Thorax largely ferruginous, sometimes the mesonotum and scutellum blackish .......... *teuta* subsp. *teuta* sp. et subsp. nov.

Thorax largely blackish, only the metapleuræ and propodeum ferruginous .......... *teuta* subsp. *vicinaria* subsp. nov.

FEMALES

1. Thorax somewhat longer than broad, the dorsum distinctly, longitudinally striate-punctate, the lateral margins of mesonotum not conspicuously dentate, at least anteriorly; sides of propodeum glabrous, impunctate .......... 2.

Thorax as broad as long or broader, the dorsum not striate-punctate, entirely densely, confluently punctate, the lateral margins of the mesonotum conspicuously dentate; sides of propodeum with small, close, distinct punctures .......... 5.

2. Integument beneath pale pubescent, apical band of second tergite black; tergites three to five each with a median, apical spot of pale pubescence; posterior margin of dorsum of propodeum armed with a row of erect teeth .......... *deserta* (Smith).

Integument beneath pale pubescent, apical band of second tergite whitish; at least tergite three without a median, pale pubescent spot; posterior margin of dorsum of propodeum comparatively unarmed, at the most defined by a crenulate raised line, or with a median tooth .......... 3.

3. Lamellate process of mesopleuræ moderately developed, the ventrodorsal dimension the greatest; femora entirely black.
*galatea* sp. nov.

Lamellate process of mesopleuræ very conspicuous, the proximodistal dimension as great as or greater than the ventrodorsal dimension; at least the proximal half of femora ferruginous .......... 4.

4. Proximodistal dimension of lamellate process about equal to the ventrodorsal dimension, the distal margin of the process arcuate; fourth abdominal tergite without a median, pale pubescent spot; posterior margin of dorsum of propodeum with a median tooth.
*byblis* sp. nov.

Proximodorsal dimension of lamellate process distinctly greater than the ventrodorsal dimension, the distal margin of the process acutely

angulate, the process subtriangular; fourth tergite with a small, median, apical, pale pubescent spot; posterior margin of dorsum of propodeum defined by a crenulate raised line.
*subtriangularis* sp. nov.

5. Posterior margin of dorsum of propodeum armed with a row of erect teeth; dorsum of propodeum angulately separated from the posterior face, the latter with sparse, obscure punctures...... *oblectabilis* sp. nov.

Posterior margin of dorsum of propodeum defined by an obscure, serrate, raised line; dorsum of propodeum rounded into the posterior face, the latter with small, dense punctures................ *fucosa* sp. nov.

**SQUAMULOTILLA BYBLIS sp. nov.**

*Female.*—Black, except the thorax entirely, scape, pedicel, first abdominal sternite, coxæ, trochanters, proximal half of femora, and distal four tarsal segments, all ferruginous, and the integument beneath the pale pubescent markings on first and second abdominal segments white; posterior margin of dorsum of propodeum with a prominent, median tooth; first abdominal tergite with an apical, median spot, the second tergite with a broad, apical band slightly dilated medially, both of pale, glittering pubescence; fifth tergite with a large, median, transverse spot of pale pubescence. Length, 9 millimeters.

Head black, the scape and pedicel pale ferruginous; flagellum beneath, beyond the second segment, tinged with ferruginous; distal half of mandibles dark mahogany red; mandibles somewhat broadened distally, the distal end blunt and rounded and with two small teeth within near the apex; clypeus with an elevated, arcuate ridge medially, the lateral termini of the ridge at the anterior margin, the median point of the ridge at the posterior margin, the ridge trituberculate, a distinct tubercle at each of the lateral termini and at the median point; antennal tubercles glabrous, impunctate, contiguous at their base; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum almost equal in length to the second and third united; antennal scrobes distinctly carinate above; front, vertex and genæ with moderate, dense, confluent punctures, the front and vertex with long, scattered, erect, and sparse, short, semirecumbent pubescence, the genæ with sparse, pale pubescence; a few pale hairs on the front at the base of the antennal tubercles; posterior margin of genæ defined by a crenulate carina; a prominent, transverse, sharp ridge midway between the gular orifice and the foramen; head moderately well developed behind the eyes, the distance between the eye margins and the posterolateral angles equal to five-ninths of the greatest diameter of the eyes; relative widths of head and thorax, 4.4: 4.1.

Thorax entirely ferruginous; dorsum of thorax densely, longitudinally striate-punctate, the punctures moderate, except near the lateral margins of the mesonotum a slightly convex area with the punctures small, also with a more or less distinct, median, longitudinal carina, clothed throughout with long, scattered, erect, and sparse, short, semirecumbent, obscurely ferruginous pubescence; lateral margins of dorsum of thorax margined; pronotum wider than remainder of thorax, the lateral margins roundly angulate medially, anteriorly with a pair of very distinct tubercles, one each at a point two-fifths the distance from the posterolateral angles to the midline; lateral margins of mesonotum straight and parallel on anterior half, the posterior half with three tubercles, the anterior two rounded, blunt, the posterior one acute, prominent, and situated just anterior to the propodeal spiracles; thorax distinctly constricted at the propodeal spiracles; dorsum of propodeum with moderate, dense, confluent punctures; propodeum without a transverse row of erect, distinct teeth separating the dorsal and posterior faces, but with a prominent median tooth at the posterior margin of the dorsum; posterior face of propodeum with a median, longitudinal carina its entire length, shallowly, obscurely reticulate, clothed with sparse, long, erect, obscurely ferruginous pubescence; lateral margins of posterior face of propodeum dentate; anterior margin of propleuræ sinuate with a prominent, thick, blunt tubercle midway between the ventral and dorsal angles; lamellate process on mesopleuræ above middle coxæ large and conspicuous, the anterior face distinctly concave, the posterior face convex; dorsoventral width of lamellate process equal to one-third the distance from the coxal cavities to the dorsal margin of mesopleuræ; pleural areas throughout glabrous, obscurely micropunctate and with sparse, appressed, pale micropubescence.

Abdomen black, except the first sternite ferruginous and the integument beneath the median, pale pubescent spot of first tergite and apical pale pubescent band of second tergite, whitish; anterior face of first tergite micropunctate and also with scattered, small punctures, clothed with sparse, erect, pale fuscous pubescence; dorsal face of first tergite with small, dense punctures and short, black pubescence, except a large, median spot of dense, appressed, pale, glittering pubescence; second tergite with small, dense punctures on the disk, laterally with moderate, separated punctures, the disk clothed with short, black pubescence, and scattered, erect, black hairs, the lateral areas with sparse, erect, pale hairs, the apical margin with a moderately broad, apical band, roundly dilated medially, of thick, appressed, pale, glittering pubescence; lateral margins of second tergite with short, thick, pale pubescence; third and fourth tergites with fine, dense punctures, clothed with sparse, appressed, and scattered, erect, black pubescence, except laterally the erect hairs pale, and the lateral margins with obscure, pale pubescence; fifth tergite punctured and pubescent like the third and fourth except for a large, transverse, median spot of thick, appressed, pale pubescence, the anterior margin of the pale spot arcuate; last tergite with small, dense punctures and sparse, pale pubescence, except the pygidial area glabrous, impunctate, nor margined laterally; first sternite with a prominent, median, longitudinal carina; second sternite with a median, longitudinal carina on the anterior two-thirds, and with a distinct, slightly concave area each side of the median carina, with moderate, close punctures, except the concave areas more or less glabrous and obscurely punctate, clothed with sparse, pale pubescence; sternites three to five with moderate, close to dense punctures posteriorly; sternites two to five, each with a thin, apical fringe of pale hairs; hypopygium acute at the apex, with small, dense punctures and sparse, pale pubescence.

Coxæ, trochanters, proximal half of femora, and the four distal tarsal segments, all ferruginous; distal half of femora, tibiæ, and first tarsal segment black; legs finely punctured and clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49314, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, 7 females, Mount Maquiling (*Baker*); female, Los Baños (*Baker*); 2 females, Mount Banahao, February 23, 1917 (*F. X. Williams*); 4 females, Mount Banahao (*Baker*); female, Mount Banahao. SIBUYAN, female (*Baker*).

Related to *deserta* Smith, *subtriangularis* Mickel, and *galatea* Mickel, all of which have the thorax of the same general form; it differs from those species in the form of the lamellate process of the mesopleuræ, in the pubescent markings of the abdomen, and in the color of the legs, as well as in the arming of the posterior margin of the dorsum of propodeum.

**SQUAMULOTILLA SUBTRIANGULARIS sp. nov.**

*Female.*—Head, abdomen, distal two-thirds of femora above, tibiæ entirely, and first segment of tarsi, all black, except the integument beneath the apical pale pubescent band of second abdominal tergite, whitish; thorax entirely, coxæ, trochanters, proximal third of femora above, femora entirely beneath, and four distal tarsal segments, all ferruginous; posterior margin of dorsal surface of propodeum entirely unarmed; first abdominal tergite with a transverse, median, apical spot, the second tergite with a broad, apical band dilated medially, of thick, appressed, pale, glittering pubescence; fourth tergite with a small, median, apical spot, the fifth with a large, transverse spot of thick, appressed, pale pubescence. Length, 8 millimeters.

Head entirely black, except the distal half of mandibles dark mahogany red; mandibles slightly broadened at the tips, the apex blunt and rounded, with two small teeth within near the apex; clypeus elevated medially into an arcuate ridge, the lateral ends of the ridge at the anterior margin, the median point at the posterior margin, the ridge weakly trituberculate, a tubercle at each lateral extremity and one medially; antennal tubercles contiguous, glabrous, impunctate distally, closely punctate and with sparse, pale pubescence on the proximal two-thirds; scape finely, closely punctate, clothed with fine, sparse, pale pubescence; first segment of flagellum approximately equal in length to the second and third united; antennal scrobes distinctly carinate above; front, vertex, and genæ with moderate, dense, confluent punctures, the front and vertex clothed with long, scattered, erect, and sparse, short, recumbent, dark fuscous pubescence, except the front immediately posterior to the antennal scrobes with sparse, pale pubescence; genæ with sparse, pale pubescence; posterior margin of genæ defined by a denticulate ridge not extending to the posterolateral angles; head moderately well developed behind the eyes, the distance between the eye margins and the posterolateral angles equal to five-ninths the greatest diameter of the eyes; relative widths of head and thorax, 4.2 : 3.8.

Thorax entirely ferruginous; dorsum of thorax distinctly and densely, longitudinally striate-punctate, except the lateral fifths of the mesonotum convex and with small, dense punctures, clothed with scattered, long, erect, and sparse, short recumbent, obscurely ferruginous pubescence; lateral margins of pronotum straight and parallel except for a prominent, acute tubercle medially; pronotum anteriorly with a distinct tubercle at a point one-fifth the width of the thorax from the humeral angles; lateral margins of mesonotum straight and parallel on the anterior half, slightly converging on the posterior half and each margin of the latter with three rounded, obscure tubercles; thorax distinctly constricted at the propodeal tubercles; posterior margin of dorsum of propodeum entirely unarmed, without a row of erect teeth, or without a median tooth; posterior face of propodeum with a median, longitudinal carina its entire length, shallowly, obscurely reticulate, clothed with sparse, erect, pale fuscous hairs; lateral margins of posterior face of propodeum dentate; anterior margin of propleuræ defined by a sinuate carina; lamellate process of mesopleuræ enormously developed, the length from the proximal margin to the apex slightly greater than the width, subtriangular in shape, the anterior face only slightly concave, the posterior face convex, the margins translucent; pleural areas throughout glabrous, micropunctate and with pale micropubescence.

Abdomen entirely black, except the first sternite ferruginous, and the integument of the second tergite beneath the apical, pale pubescent band, whitish; anterior face of first tergite obscurely micropunctate and with scattered, moderate punctures, clothed with scattered, long, erect, pale fuscous pubescence; dorsal face of first tergite with fine, dense punctures, clothed with sparse, short, black pubescence, except a large, transverse, median spot of thick, appressed, pale, glittering pubescence; second tergite except the lateral fifths with fine, dense punctures, the lateral fifths with small, close punctures, and sparse, pale pubescence, the disk with scattered, erect, dark fuscous and sparse, short, black pubescence, and the apical margin with a broad band distinctly dilated medially of thick, appressed, pale, glittering pubescence; lateral margins of second tergite with thick, pale pubescence; third tergite with fine, dense punctures, scattered, erect, dark fuscous hairs, and short, sparse, black pubescence except the lateral extremes with sparse, pale pubescence; fourth tergite punctured and clothed like the third except with a small, median, apical spot of appressed, pale pubescence; fifth tergite punctured and clothed like the fourth except the median, apical spot of pale, appressed pubescence large, transverse and with its anterior margin arcuate; last tergite with small, dense punctures and sparse, pale pubescence except the pygidial area glabrous, impunctate and without defined lateral margins; first sternite with a median, longitudinal carina; second sternite with a median, longitudinal carina on the anterior half, a large, obscurely concave area each side of the carina, the apical margin slightly but distinctly depressed; second sternite with moderate, close, somewhat confluent punctures except the concave areas with the punctures separated, clothed with sparse, erect, pale pubescence; distal areas of sternites three to five with moderate to small, dense punctures, and sparse, pale pubescence; sternites two to five, each with a thin, apical fringe of pale pubescence; hypopygium with small, dense punctures and sparse, pale pubescence, the apex acute.

Legs ferruginous, except the distal two-thirds of femora above, tibiæ entirely and first segment of tarsi, black; legs finely punctate and clothed with pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49315, United States National Museum, MINDANAO, Iligan (*Baker*).

*Paratype.*—MINDANAO, female, Iligan (*Baker*).

Related to *byblis* Mickel, *deserta* Smith, and *galatea* Mickel. Easily recognized by the enormous, subtriangular, lamellate process of the mesopleuræ, the unarmed posterior margin of the dorsum of propodeum, and the small spot of pale pubescence on the fourth abdominal tergite.

### SQUAMULOTILLA GALATEA sp. nov.

*Female.*—Head, abdomen, and legs except the coxæ, black, except the integument beneath the apical, pale pubescent band of the second abdominal tergite, whitish; thorax and coxæ ferruginous; dorsum of propodeum with a small, inconspicuous, median tooth at the posterior margin; lamellate process of mesopleuræ distinct but not conspicuously developed as in *byblis* and *subtriangularis;* first abdominal tergite with a large, median, apical, transverse spot of dense, pale, glittering pubescence extending slightly onto the base of the second tergite, the latter also with a broad, apical band, dilated medially, of similar pubescence; fifth tergite with a median, apical, transverse spot of thick, appressed, pale pubescence. Length, 8.5 millimeters.

Head entirely black, except the flagellum beneath tinged with ferruginous and the distal half of the mandibles dark mahogany red; mandibles somewhat broadened at the tips, the apices bluntly rounded and with two small teeth within near the apex; clypeus arcuately elevated medially, the elevated margin obscurely trituberculate, a tubercle at each lateral end of the ridge and one at the median point; antennal tubercles contiguous, for the most part glabrous, impunctate, but at the base with moderate, close punctures and sparse, pale pubescence; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum approximately equal in length to the second and third united; antennal scrobes distinctly carinate above; front, vertex, and genæ with moderate, dense, confluent punctures; front and vertex with scattered, long, erect, and sparse, short, recumbent, dark fuscous pubescence except the front at the extreme anterior margin with some sparse, pale pubescence; genæ clothed with sparse, pale pubescence; genæ defined posteriorly by an obscure, crenulate ridge; head moderately well developed behind the eyes, the distance between the eye margins and the posterolateral angles equal to eleven-eighteenths the greatest diameter of the eyes; relative widths of head and thorax, 4.3 : 3.9.

Thorax entirely ferruginous; dorsum of thorax densely, longitudinally striate-punctate, the punctures moderate in size, except the lateral fifths of the mesonotum slightly convex and with small, dense punctures, clothed with scattered, long, erect, and short, sparse, recumbent, obscurely ferruginous pubescence; lateral margins of pronotum distinctly angulate, the pronotum with a small tubercle anteriorly at about one-sixth of the width of the pronotum from the humeral angle; anterior half of lateral margins of mesonotum approximately straight and parallel, the posterior half slightly converging and trisinuate; thorax distinctly constricted at the propodeal tubercles; posterior margin of dorsum of propodeum formed by a crenulate line, with a small, inconspicuous tooth medially; posterior face of propodeum with a median, longitudinal carina its entire length, obscurely reticulate, clothed with scattered, long, erect, pale fuscous pubescence; lateral margins of posterior face of propodeum dentate; anterior margin of propleuræ defined by a sinuate carina; lamellate process of mesopleuræ distinct but not unusually prominent, its dorsoventral dimension about twice its cephalocaudal dimension; pleural areas glabrous throughout, obscurely micropunctate and sparsely clothed with pale micropubescence.

Abdomen entirely black, except the first sternite ferruginous and the integument of the second tergite beneath the apical, pale pubescent band, whitish; anterior face of first tergite micropunctate, also with scattered, moderate punctures, and scattered, erect, pale pubescence; dorsal face of first tergite with fine, dense punctures, clothed with sparse, short, black pubescence, except laterally with sparse, pale pubescence, and medially with a large, apical subquadrate spot of thick, appressed, pale, glittering pubescence, this spot extending slightly onto the anterior margin of the second tergite; second tergite with small, dense punctures, except laterally the punctures slightly larger and not so dense, the disk clothed with scattered, long, erect, and short, sparse, recumbent, black pubescence, the lateral fifths with sparse, pale pubescence, the apical margin with a broad, apical band dilated medially, of thick, appressed, pale, glittering pubescence, and the lateral margins with thick, pale pubescence; tergites three to five with fine, dense punctures, clothed with scattered, long, erect, and sparse, short, recumbent, black pubescence, except near the lateral margins the pubescence pale, and the fifth tergite with a median, apical, transverse spot of thick, appressed, pale pubescence, the anterior margin of the pale pubescent spot arcuate; last tergite with small, dense punctures and sparse, pale pubescence except the pygidial area glabrous, impunctate, not margined laterally; first sternite with a median, longitudinal carina; second sternite with a median, longitudinal carina on the anterior half, a distinct slightly concave area each side of the carina; second sternite with moderate, close punctures, the latter more separated on the concave areas, and clothed with sparse, pale pubescence; sternites three to five with small, dense punctures posteriorly, clothed with sparse, pale pubescence: sternites two to five each with a thin, apical fringe of pale hairs; hypopygium with small, dense punctures and sparse, pale pubescence, the apex acute.

Legs entirely black, except the ferruginous coxæ, finely, closely punctate, and clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49316, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, 2 females, Mount Maquiling (*Baker*); female, Los Baños, August, 1916 (*F. X. Williams*); female, Los Baños, September, 1917 (*F. X. Williams*); 2 females, Los Baños, 1916 (*F. X. Williams*); female, Los Baños (*F. X. Williams*); 2 females, Los Baños (*Baker*); female, Baguio, June, 1917 (*F. X. Williams*); female, Paete.

Related to *byblis* Mickel, *subtriangularis* Mickel, and *deserta* Smith. It differs from the first two in the relatively weak development of the lamellate process of the mesopleuræ; also differs from the first in the color of the legs and scape, and from the second in the color of the legs and absence of the pale pubescent spot on the fourth tergite; it differs from *deserta* in the absence of pale pubescent spots on tergites three and four and in the absence of a transverse row of teeth at the posterior margin of the dorsum of propodeum.

**SQUAMULOTILLA DESERTA (Smith).**

1879. *Mutilla deserta* SMITH, Descr. New Species Hymen. 200, female.
1879. *Mutilla deserta* DALLE TORRE, Cat. Hymen. 8: 30, female.
1903. *Mutilla deserta* ANDRÉ, Gen. Ins. 1, fasc. 11: 39, female.

*Holotype.*—Female, Celebes, in British Museum of Natural History.

*Specimens examined.*—LUZON, 3 females, Los Baños, August, 1916 (*F. X. Williams*); female, Los Baños, September, 1917 (*F. X. Williams*); 2 females, Los Baños, 1917 (*F. X. Williams*); 2 females, Los Baños (*Baker*); female, Manila, January 29, 1906 (*C. S. Banks*); female, Mount Maquiling (*Baker*); female, Baguio, Benguet (*Baker*); female.

This species is related to the three preceding species but differs from all of them in having a distinct, transverse row of teeth at the posterior margin of the dorsum of propodeum, in having the integument beneath the apical, pale pubescent band of the second abdominal tergite black instead of whitish, and in the presence of a median, apical, pale pubescent spot on each of tergites three to five. The thorax in all four species is of the same general outline, differing from that of the two following species. Unfortunately, I have not had an opportunity to compare these specimens with Smith's type from Celebes although I have examined the latter. Neither my notes nor Smith's description gives any basis for discriminating between specimens of the two localities; it is possible a direct comparison of the two might disclose differences between them.

**SQUAMULOTILLA OBLECTABILIS sp. nov.**

*Female.*—Head and abdomen black, except the integument beneath the median, pale pubescent spot of first tergite and apical pale pubescent band of second tergite, whitish; thorax, proximal half of mandibles, scape, pedicel, coxæ, trochanters, and femora, all ferruginous; tibiæ and tarsi dark brown; thorax broader than long, the lateral margins of the dorsum conspicuously dentate; posterior margin of dorsum of propodeum armed with a transverse row of vertical teeth; sides of propodeum with small, distinct punctures; first sternite without a distinct, longitudinal, median carina. Length, 5 millimeters.

Head black, except the antennal tubercles, scape, pedicel, and proximal half of mandibles, pale ferruginous; distal half of mandibles dark mahogany red; mandibles not broadened at the tips, more or less acute, with a single tooth within near the apex; clypeus elevated medially into an arcuate ridge, the latter trituberculate, with a small tubercle medially, and one at each lateral extremity; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum about equal in length to the second and third united; flagellum tinged beneath with pale ferruginous; antennal scrobes distinctly carinate above; front, vertex, and genæ with small, dense, confluent punctures; front, vertex with scattered, long, erect, pale fuscous hairs, and short, sparse, recumbent, dark fuscous pubescence; genæ clothed with sparse, pale pubescence; genæ rounded posteriorly, the posterior margin not well defined but with a small, inconspicuous tooth anteriorly a short distance posterior to the insertion of the mandibles; head weakly developed behind the eyes, the distance between the eye margins and the posterolateral angles equal to about one-third the greatest diameter of the eyes; relative widths of head and thorax, 2.5 : 2.6.

Thorax entirely pale ferruginous, slightly broader than long; lateral margins of the dorsum dentate, the lateral margin of the pronotum with a small, acute tooth, the margins of the mesonotum with a small, blunt, anterior tooth and a large median tooth, the margins crenulate where not toothed; dorsum of thorax with moderately small, dense, confluent punctures throughout, not at all striate-punctate, clothed with sparse, short, recumbent, ferruginous pubescence; anterior margin of pronotum with a small tubercle each side at about one-sixth the width of the thorax mesad of the humeral angles; thorax distinctly constricted at the propodeal tubercles; posterior margin of dorsum of propodeum armed with a transverse row of erect teeth separating distinctly the dorsum of the thorax and the posterior face of propodeum, the latter with sparse, obscure punctures, and scattered, long, erect, pale hairs; lateral margins of posterior face of propodeum dentate; anterior margin of propleuræ defined by a sinuate carina; lamellate process of mesopleuræ moderately developed, the distal margin with two distinct angles; pleural areas glabrous, micropunctate and micropubescent, except the sides of the propodeum with small, close, distinct punctures.

Abdomen black, except the first sternite ferruginous, and the integument beneath the median, pale pubescent spot of the first tergite and the apical, pale pubescent band of the second tergite, whitish; anterior face of first tergite with small, close, distinct punctures, sparser anteriorly and laterally, clothed with scattered, long, erect, pale fuscous pubescence; dorsal face of first tergite with fine, dense punctures, clothed with short, black pubescence, except a large, subquadrate, transverse, median spot of appressed, pale pubescence; second tergite with small, dense, confluent punctures, the latter slightly separated laterally, clothed with scattered, erect, long, dark fuscous hairs, and short, black, recumbent pubescence, except the median spot of the first tergite extending obscurely on the base of the second, the lateral fifths of the latter with sparse, pale pubescence, and the apical margin of the second with an apical band, broadly dilated medially of sparse, appressed, pale pubescence; tergites three to five with small, dense punctures becoming finer and denser toward their posterior margins, clothed with scattered, long, erect, dark fuscous hairs and sparse, short, recumbent, black pubescence, except the lateral extremes with pale pubescence, and the fifth tergite with a narrow, transverse, median, apical spot of pale pubescence; last tergite with small, dense punctures and sparse, pale pubescence, except the pygidial area glabrous, unsculptured, not margined laterally; first sternite without a median, longitudinal carina; second sternite with moderately small, close, distinct punctures, becoming sparser anteriorly, clothed with sparse, pale pubescence; sternites three to five with small, dense punctures posteriorly, clothed with sparse, pale pubescence; sternites two to five each with a thin, apical fringe of pale hairs; hypopygium with small, dense punctures and sparse, pale pubescence, the apex acute.

Legs ferruginous, except the tibiæ and tarsi dark brown, with fine punctures and sparse, pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49317, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, 9 females, Mount Maquiling (*Baker*); female, Baguio, Benguet (*Baker*).

This and the following species differ from the preceding four in the shape and sculpture of the thorax, and the dentition of the lateral margins of the thorax. *Squamulotilla oblectabilis* differs from *fucosa* in having the posterior margin of the dorsum of propodeum armed and in the posterior face of the propodeum being only obscurely punctured.

### SQUAMULOTILLA FUCOSA sp. nov.

*Female.*—Head and abdomen black, except the first sternite ferruginous, and the integument beneath the median, apical, pale pubescent spot of the first abdominal tergite and the apical, pale pubescent band of the second tergite, yellowish; thorax, scape, and legs entirely pale ferruginous; thorax about as broad as long, the lateral margins of the dorsum dentate and crenulate; dorsum of propodeum rounded into the posterior face of propodeum, the posterior margin of the dorsum unarmed, indicated only by an obscure, serrate, raised line; posterior face of propodeum densely punctate; sides of propodeum with small, distinct punctures; first abdominal sternite without a median, longitudinal carina. Length, 5.5 millimeters.

Head black, except the front with an obscure, dark ferruginous tinge, and the mandibles, clypeus, antennal tubercles, scape, and pedicel, pale ferruginous; mandibles not noticeably broadened at the tips, the apices bluntly rounded and with a small, inconspicuous tooth within near the apex; clypeus elevated into an arcuate ridge, the latter not noticeably tuberculate; antennal tubercles contiguous, glabrous; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum about equal in length to the second and third segments united; antennal scrobes distinctly carinate above; front, vertex, and genæ with small, dense, confluent punctures; front and vertex clothed with scattered, long, erect, and sparse, short, recumbent, fuscous pubescence; genæ with sparse, pale pubescence; posterior margin of genæ defined by an obscure ridge, the latter terminating anteriorly in a small, blunt tooth; head weakly developed behind the eyes, the distance between the eye margins and the posterolateral angles equal to about five-twelfths the greatest diameter of the eyes; relative widths of head and thorax, 2.6 : 2.5.

Thorax entirely ferruginous, the dorsum moderately, densely, confluently punctate throughout, clothed with scattered, long, erect, and sparse, short, recumbent, ferruginous pubescence; lateral margins of dorsum of thorax conspicuously dentate and crenulate, the pronotum with the humeral angles dentate and with a conspicuous, median tooth on the lateral margins, the lateral margins of the mesonotum strongly angulate just anterior to the middle and with a prominent postmedian tooth; thorax distinctly constricted at the propodeal spiracles; anterior margin of pronotum with a small, inconspicuous tubercle about one-sixth the width of the thorax mesad of the humeral angles; an obscure arcuate carina separating the mesonotum and dorsum of propodeum but not extending to the lateral margins of the thorax; posterior margin of dorsum of propodeum unarmed, indicated only by an obscure, serrated, raised line, the dorsum of propodeum rounded into the posterior face, the latter with small, dense punctures and sparse, long, erect, pale pubescence; anterior margin of propleuræ defined by a sinuate carina; lamellate process of mesopleuræ moderately developed, the ventral distal angle most prominent; propleuræ micropunctate and micropubescent, the mesopleuræ and metapleuræ glabrous, impunctate, bare; sides of propodeum with small, close, distinct punctures; lateral margins of posterior face of propodeum conspicuously dentate.

Abdomen black, except the first abdominal sternite ferruginous, the integument beneath the pale pubescent markings of the first and second tergites, yellowish, and the margins of the tergites more or less ferruginous; anterior face of first tergite with small, sparse punctures becoming close posteriorly, clothed with scattered, long, erect, pale pubescence; dorsal face of first tergite with fine, dense punctures and short, sparse, recumbent, black pubescence, except laterally with sparse, pale pubescence and medially with a large, subquadrate spot of sparse, appressed, pale pubescence; second tergite with small, dense, confluent punctures, except laterally the punctures separated and more distinct, clothed with scattered, erect, dark fuscous pubescence, and short, sparse, recumbent, black pubescence, except laterally with sparse, pale pubescence and the apical margin with a broad band, broadly dilated medially, of sparse, appressed, pale pubescence; tergites three to five with small, dense punctures, clothed with scattered, erect, dark fuscous pubescence and short, sparse, recumbent, black pubescence, except the lateral extremes pale pubescent and the fifth tergite with a small, median, apical spot of pale pubescence; last tergite with small, dense punctures and sparse, pale pubescence except the pygidial area glabrous, impunctate and not margined laterally; first abdominal sternite without a median, longitudinal carina; second sternite with moderate, distinct punctures and sparse, pale pubescence; sternites three to five with small, close punctures posteriorly, clothed with sparse, pale pubescence; sternites two to five each with a thin, apical fringe of pale pubescence; hypopygium with small, dense punctures, distinctly angulate at the apex.

Legs entirely ferruginous, finely punctured, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49318, United States National Museum, MINDANAO, Surigao (*Baker*).

*Paratypes.*—MINDANAO, female, Surigao (*Baker*); female, Tangkulan, Bukidnon Province (*Baker*); female, Iligan (*Baker*).

The color of the front, vertex, and genæ in the paratypes varies from distinctly ferruginous to black tinged with ferruginous. Related to *oblectabilis* from which it differs by the absence of the row of vertical teeth at the posterior margin of dorsum of propodeum, and by the posterior face being densely punctate and rounded into the dorsum.

### SQUAMULOTILLA OCYPOTE sp. nov.

*Male.*—Head and abdomen dark metallic blue, except the base of the first abdominal segment ferruginous; thorax ferruginous except the pronotum, mesonotum and scutellum suffused with metallic blue; legs dark mahogany red, except the coxæ pale ferruginous; second abdominal tergite with moderate, distinct punctures separated by about their own width; first sternite without a median, longitudinal carina; hypopygium not elevated anteriorly; wings with only a single cubital cell, both $R_5$ and $R_4$ absent. Length, 6 millimeters.

Head dark metallic blue, clothed throughout with sparse, pale pubescence; mandibles slender, acute at the tips, and with two distinct teeth within near the apex; subtriangular median area of clypeus slightly elevated, the anterior margin of the elevation somewhat concave; scape not carinate beneath, with fine, close punctures and sparse, pale pubescence; first segment of flagellum equal in length to the second; antennal scrobes distinctly carinate above; front and vertex with small, close, more or less confluent punctures, the genæ with small, dense punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 2.5 : 2.5.

Thorax ferruginous, except the pronotum, mesonotum and scutellum suffused with metallic blue, clothed throughout with sparse, pale pubescence, somewhat thicker on the mesopleuræ than elsewhere; pronotum and mesonotum with moderate, close, somewhat confluent punctures; lateral margins of pronotum with a small, median, inconspicuous tubercle; scutellum moderately, evenly convex, with moderate, dense punctures; dorsum and posterior face of propodeum distinctly, shallowly reticulate, rounded into one another, the dorsum without a median, inclosed space; propleuræ defined anteriorly by a distinct carina, with moderate, close punctures; mesopleuræ convexly elevated ventrally and dorsally, the two areas separated by a furrow, the entire surface with moderate, close punctures; metapleuræ glabrous, impunctate; sides of propodeum with moderate, dense punctures; lateral margins of posterior face of propodeum crenulate; tegulæ obscure ferruginous, small, subcircular, with small punctures and pale pubescence throughout.

Abdomen dark metallic blue, except the anterior portion of the first segment ferruginous, clothed throughout with very sparse, long, erect, pale pubescence; first tergite with scattered, moderate, shallow punctures; second tergite with moderate, distinct punctures separated by about their own width, except becoming close at the anterolateral margin; tergites three to six with moderate, distinct punctures; last tergite with small, dense punctures and somewhat thick, pale pubescence; first sternite without a median, longitudinal carina; second sternite rather evenly convex, with moderate, close punctures, and with a small tubercle at the median anterior margin; sternites three to six with small, close to separated punctures posteriorly; hypopygium not elevated anteriorly.

Legs dark mahogany red, except the coxæ pale ferruginous, finely punctate and clothed with sparse, pale pubescence; calcaria pale.

Wings subfuscous; cell 2d $R_1 + R_2$ large, triangular in outline, the apex acute; only a single cubital cell present, both $R_5$ and $R_4$ absent.

*Holotype.*—Male, catalogue No. 49319, United States National Museum, LUZON, Tayabas Province, Malinao (*Baker*).

Related to *dictynna* and *imparilis* but differs in having the lateral margins of the pronotum tuberculate, in the metallic blue color of the pronotum, mesonotum, and scutellum, and in the puncturation of the second abdominal segment.

### SQUAMULOTILLA DICTYNNA sp. nov.

*Male.*—Head and abdomen dark metallic blue, except the base of the first abdominal segment ferruginous; scape and pedicel obscurely pale ferruginous, the flagellum blackish; thorax and coxæ ferruginous; legs excepting coxæ blackish; lateral margins of pronotum forming straight lines, not tuberculate, crenulate, or denticulate; second abdominal tergite with sparse, fine punctures, separated for the most part by three times their own diameter; first sternite without a median, longitudinal carina; hypopygium not elevated anteriorly; wings with a single cubital cell, cells $R_5$ and $R_4$ both absent. Length, 6 millimeters.

Head entirely dark metallic blue, clothed throughout with scattered, long, erect, and sparse, short, recumbent, pale pubescence; mandibles slender, bluntly rounded at the tips, and with two small teeth within near the apex; median triangular area of clypeus convexly and slightly elevated, the anterior angles of the elevation feebly tuberculate; antennal tubercles contiguous and glabrous; scape with fine, close punctures and sparse, pale pubescence; antennal scrobes carinate above; front with small, close but distinct punctures, the vertex and genæ with small, very close, confluent punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 2.3 : 2.5.

Thorax entirely ferruginous, clothed throughout with sparse, erect and recumbent, pale pubescence, thickest on the mesopleuræ; pronotum and mesonotum with moderate, close, more or less confluent punctures; lateral margins of pronotum straight not at all tuberculate; scutellum evenly convex, with moderate, dense punctures; dorsum of propodeum and posterior face of propodeum distinctly shallowly reticulate, the one rounded into the other, the dorsum without a median, inclosed space; lateral margins of posterior face of propodeum obscurely crenulate; propleuræ defined anteriorly by a sinuate carina, with small, dense punctures; mesopleuræ convexly elevated ventrally and dorsally, the two regions separated by a furrow, the ventral elevation with small, sparse punctures, the dorsal with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum punctate-reticulate; tegulæ small, convex, subcircular, sparsely punctured and pubescent.

Abdomen dark metallic blue, except the first segment at the base, ferruginous; first tergite with scattered, small punctures, somewhat closer anteriorly; second tergite with sparse, fine punctures, separated for the most part by three times their own diameter; tergites three to six with small, distinct, sparse to close punctures; last tergite with small, close punctures; first sternite without a median, longitudinal carina; second sternite with small, sparse, distinct punctures; sternites three to six with small, close, distinct punctures; hypopygium not elevated anteriorly.

Coxæ ferruginous, the remainder of the legs blackish, finely punctate and clothed with sparse, pale pubescence; calcaria pale.

Wings subhyaline; cell 2d $R_1 + R_2$ large, triangular, acute at the apex; only a single cubital cell present, cells $R_5$ and $R_4$ absent.

*Holotype.*—Male, catalogue No. 49320, United States National Museum, MINDANAO, Tangkulan, Bukidnon (*Baker*).

Related to *ocypote* and *imparilis.* It differs from *ocypote* in the entirely ferruginous thorax, straight lateral margins of the pronotum, clypeus of slightly different form, and sparser puncturation of the second abdominal tergite.

**SQUAMULOTILLA IMPARILIS** sp. nov. Plate 1, fig. 1.

*Male.*—Head dark metallic blue, thorax entirely ferruginous, abdomen above dark metallic blue, below with violaceous reflections, except the base of the first segment ferruginous; coxæ ferruginous, remainder of legs blackish; anterior half of pronotum slightly constricted, the lateral margins sinuate, not forming a straight line; second tergite with sparse, small punctures separated by one to two times their own diameter; first abdominal sternite without a median, longitudinal carina; hypopygium not elevated anteriorly; wings with a single cubital cell, $R_5$ and $R_4$ entirely absent. Length, 6 millimeters.

Head entirely dark metallic blue, except the mandibles ferruginous and the antennæ blackish, clothed throughout with sparse, pale pubescence; mandibles slender, somewhat blunt at the tips and with two small teeth within near the apex; median, triangular area of clypeus slightly, convexly elevated, with fine, sparse punctures, the angles at the anterior margin slightly tuberculate; antennal tubercles slightly separated by a shallow, median furrow on the front; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum about equal in length to the second; antennal scrobes distinctly carinate above; front with small, distinct punctures separated by somewhat less than their own diameter; vertex and genæ with small, dense punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax at the tegulæ, 2.4 : 2.4.

Thorax entirely ferruginous, clothed throughout with sparse, erect and recumbent, pale pubescence, thickest on the mesopleuræ; pronotum and mesonotum with moderate, close, more or less confluent punctures; scutellum slightly but evenly convex, with moderate, dense punctures; pronotum slightly constricted on the anterior half, the lateral margins sinuate, not forming a straight line; dorsum and posterior face of propodeum distinctly but shallowly reticulate, the one rounding into the other, and the dorsum without an inclosed space; anterior margin of propleuræ defined by a distinct carina, the propleuræ obscurely punctate; mesopleuræ elevated ventrally and dorsally, the two areas separated by a furrow, and both with moderate, shallow, close but distinct punctures; metapleuræ glabrous, impunctate; lateral margins of posterior face of propodeum defined by a crenulate raised line; sides of propodeum with small, distinct punctures; tegulæ small, subcircular, dark ferruginous, with small, scattered punctures and sparse, pale pubescence.

Abdomen above dark metallic blue, below with violaceous reflections, except the base of the first segment ferruginous, clothed throughout with sparse, erect, pale pubescence; first tergite with small, sparse punctures; second tergite with small, sparse punctures, separated by one to two times their own diameter, somewhat closer anteriorly than posteriorly; tergites three to six with small, close, distinct punctures; last tergite with small, dense punctures; first abdominal sternite without a median, longitudinal carina; second sternite with small, close, but distinctly separated punctures; sternites three to six with small, close punctures; hypopygium not elevated anteriorly.

Coxæ dark ferruginous, remainder of legs dark mahogany red; finely punctate and clothed with sparse pubescence; calcaria pale.

Wings subhyaline; cell 2d $R_1 + R_2$ triangular, the apex acute; only a single cubital cell present, both $R_5$ and $R_4$ absent.

*Holotype.*—Male, catalogue No. 49321, United States National Museum, LUZON, Mount Maquiling (*Baker*).

Related to *dictynna* and *disjuncta.* May be separated from both by the small, distinct punctures on sides of propodeum. Differs from *dictynna* in the sinuate lateral margins of pronotum and less sparsely punctured second abdominal tergite. Differs from *disjuncta* in the puncturation of the second tergite and the closer puncturation of the second sternite.

### SQUAMULOTILLA DISJUNCTA sp. nov.

*Male.*—Head dark metallic blue; thorax entirely ferruginous; abdomen with dark metallic blue to violaceous reflections; coxæ ferruginous, remainder of legs dark mahogany red; anterior half of pronotum narrow, the lateral margins not forming a straight line but sinuate; second tergite with sparse, fine punctures, separated by two to three times their own diameter; second sternite with sparse, fine punctures; first sternite without a median, longitudinal carina; hypopygium not elevated anteriorly; wings with a single cubital cell, both $R_5$ and $R_4$ absent. Length, 4.5 millimeters.

Head entirely dark metallic blue, except the mandibles ferruginous, and the antennæ obscure dark ferruginous, clothed throughout with sparse, pale pubescence; mandibles slender, blunt at the tip with two small teeth within near the apex; median, triangular area of clypeus slightly, convexly elevated, the anterior angles slightly tuberculate, with sparse, fine punctures; antennal tubercles distinctly separated; scape with fine punctures and sparse, pale pubescence; first segment of flagellum about equal in length to the second; antennal scrobes carinate above; front with small, close, distinct punctures, the vertex and genæ with small, dense punctures; front with a shallow, but distinct median, longitudinal furrow; posterior margin of genæ rounded, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 1.8 : 1.8.

Thorax entirely ferruginous, clothed throughout with sparse, erect and recumbent, pale pubescence, thickest on the mesopleuræ; pronotum slightly but distinctly narrowed anteriorly, the lateral margins slightly sinuate; pronotum and mesonotum with small, dense, more or less confluent punctures; scutellum with small, dense punctures; dorsum of propodeum and posterior face of propodeum shallowly, distinctly reticulate, the one rounded into the other, the lateral margins of the posterior face defined by a crenulate, raised line; anterior margin of propleuræ defined by a carina, the propleuræ obscurely punctate; mesopleuræ slightly, convexly elevated ventrally and dorsally, the two elevations separated by a furrow, with fine, close distinct punctures becoming sparse anteriorly and posteriorly; metapleuræ glabrous, impunctate; sides of propodeum distinctly reticulate; tegulæ small, subcircular with sparse punctures and pubescence.

Abdomen with dark metallic blue and violaceous reflections, clothed throughout with sparse, long, erect, pale pubescence; first tergite with sparse, fine punctures; second tergite with fine punctures separated by two to three times their own diameter, closer anteriorly; tergites three to six with sparse, fine punctures; last tergite with fine, close punctures; first sternite without a median, longitudinal carina; second sternite with sparse, fine punctures separated by almost twice their own diameter; sternites three to six with fine close punctures; hypopygium not elevated anteriorly.

Coxæ ferruginous, remainder of legs dark mahogany red, with fine punctures and sparse, pale pubescence; calcaria pale.

Wings subhyaline; cell 2d $R_1 + R_2$ triangular, the apex acute; only a single cubital cell, $R_5$ and $R_4$ entirely absent.

*Holotype.*—Male, catalogue No. 49322, United States National Museum, LUZON, Baguio, Benguet (*Baker*).

*Paratype.*—LUZON, male, Mount Maquiling (*Baker*).

The paratype differs from the type in having the mesonotum and scutellum suffused with metallic blue. *Squamulotilla disjuncta* may be recognized from the preceding related species by the distinctly reticulate sides of propodeum, the separated antennal tubercles, and the puncturation of the second abdominal tergite and sternite.

### SQUAMULOTILLA CONCAVA sp. nov.

*Male.*—Entirely dark metallic blue, almost black, clothed throughout with sparse, pale pubescence, thickest on the genæ and mesopleuræ, except the last two abdominal segments with fuscous pubescence; posterior face of propodeum with a distinct median, longitudinal carina; second abdominal sternite distinctly concave; first abdominal sternite without a median, longitudinal carina; hypopygium with a transverse, conspicuous carina near the proximal margin, the carina more strongly elevated and almost subangulate medially; wings with two cubital cells, only $R_4$ absent. Length, 8 millimeters.

Head entirely dark metallic blue, almost black, except the mandibles dark mahogany red, clothed with sparse, pale pubescence, thickest on the genæ; mandibles subacute at the apex, with two distinct teeth within; median area of clypeus slightly, convexly elevated, the anterior margin of the elevation shallowly concave, the clypeus with small, close punctures; antennal tubercles distinctly separated; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum equal in length to the second; antennal scrobes with a distinct, median tubercle above, without a complete carina; front with small, distinct punctures; vertex with small to moderate dense punctures; genæ with small, close punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 2.6 : 2.75.

Thorax dark metallic blue, almost black, except the pleural areas dark mahogany red, clothed with sparse, pale pubescence; erect and recumbent on the pronotum and mesonotum, erect and long on the dorsum and posterior face of propodeum, thickest on the mesopleuræ; pronotum and mesonotum with small to moderate, more or less confluent punctures; scutellum with small, close, confluent punctures; dorsum and posterior face of propodeum shallowly, distinctly reticulate, the dorsum with a median, elongate inclosed space about three times as long as broad, the posterior face with a median, elongate carina extending from the inclosed space to the posterior margin; lateral margins of posterior face of propodeum not defined, rounded into the sides; anterior margin of propleuræ defined by a carina, the propleuræ with obscure, small punctures; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by a furrow, with fine to small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum punctate-reticulate; tegulæ small, convex, subcircular, with small, sparse punctures, and sparse, pale pubescence.

Abdomen entirely dark metallic blue, almost black, clothed with long, erect, pale pubescence, except the last two segments with the pubescence fuscous; first tergite with fine, scattered punctures; second tergite with very small punctures, very sparse medially, closer at the sides; tergites three to six with small punctures, somewhat sparse on the third segment, becoming close on the sixth segment; last tergite with small, almost dense punctures, except an obscure triangular area distally very finely, closely punctate; first abdominal sternite without a median, longitudinal carina; second sternite distinctly concave almost throughout, with only a narrow area laterally and apically surrounding the concave area, the latter glabrous, obscurely rugose, the margin surrounding the concave area with small, close punctures; sternites three to six with small, distinct punctures, the latter closer on the posterior sternites than on the anterior; hypopygium with small, close punctures, and with a transverse, conspicuous, elevated ridge near the proximal margin, the ridge highest and almost subangulate medially.

Legs dark mahogany red, finely punctured and clothed with sparse, pale pubescence; calcaria pale.

Wings subfuscous with the costal area of cell 2d $R_1 + R_2$ darker than the rest of the wing; cell 2d $R_1 + R_2$ large, two and one-half times as long as broad; two distinct cubital cells, only $R_4$ absent; $R_5$ small, pentagonal; vein $M_2$ present but indistinct, joining vein $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—Male, catalogue No. 49323, United States National Museum, MINDANAO, Tangkulan, Bukidnon (*Baker*).

*Paratypes.*—MINDANAO, 5 males, Tangkulan, Bukidnon (*Baker*).

Related to *roxane* and *subdebilis* but differs from all the Philippine species of this genus by the concave second abdominal sternite.

**SQUAMULOTILLA ROXANE** sp. nov.

*Male.*—Entirely black, except the abdomen above with obscure metallic blue reflections; clothed throughout with sparse, pale pubescence, except the last two abdominal segments with fuscous pubescence; lateral margins of pronotum slightly sinuate, the humeral angles acute; first abdominal sternite without a median, longitudinal carina; hypopygium with a conspicuous, transverse, arcuate carina near the proximal margin; wings with two cubital cells, only $R_4$ absent. Length, 9 millimeters.

Head entirely black, clothed throughout with sparse, pale pubescence; mandibles subacute at the apex with two small, distinct teeth within; median area of clypeus slightly, convexly elevated, the elevated margin shallowly concave, the elevated area punctate and pubescent; antennal tubercles distinctly separated; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum very slightly shorter than the second; antennal scrobes distinctly carinate above; front with small, close, somewhat confluent punctures, the vertex and genæ with small, dense punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 3.2 : 3.6.

Thorax entirely black, clothed throughout with sparse, pale pubescence, erect and recumbent on the pronotum and mesonotum, erect and long on the dorsum and posterior face of propodeum, thickest on the mesopleuræ; lateral margins of pronotum slightly sinuate, the humeral angles slightly produced into a small, acute tubercle; pronotum and mesonotum with moderate, close, confluent punctures; scutellum convex, with a distinct, median, longitudinal furrow and small, dense punctures; dorsum and posterior face of propodeum distinctly reticulate throughout, the dorsum without an inclosed space, the posterior face without a longitudinal carina and without well-defined lateral margins but angulately separated from the sides; anterior margin of propleuræ defined by a carina, the propleuræ obscurely punctate; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by a furrow, with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum reticulate; tegulæ convex, small, with small, sparse punctures, and sparse, pale pubescence.

Abdomen black, the dorsal surface with obscure metallic blue reflections, clothed with sparse, pale pubescence, except the last two segments with fuscous pubescence; first tergite with fine, sparse punctures; second tergite with small, sparse punctures, becoming close at the anterior margin, the lateral margins broadly glabrous, impunctate; tergites three to six with small, well-separated, almost sparse punctures, the fifth also with very small, close punctures at the extreme anterior margin; last tergite with small, dense punctures, except the median line and a small, terminal, triangular area impunctate; first sternite without a median, longitudinal carina; second sternite with a feeble, median, longitudinal carina on the anterior half, and with small, sparse punctures throughout; sternites three to six with small punctures, becoming close posteriorly; hypopygium with a conspicuous, transverse, arcuate carina near the proximal margin, with fine, close punctures posterior to the carina.

Legs black, finely punctured and sparsely clothed with pale pubescence; calcaria pale.

Wings subfuscous; cell 2d $R_1 + R_2$ large, slightly more than twice as long as broad; two cubital cells present, only $R_4$ absent; $R_5$ small, pentagonal; vein $M_2$ uniting with $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—Male, catalogue No. 49324, United States National Museum, NEGROS, Cuernos Mountains (*Baker*).

Related to *concava* and *subdebilis;* differs from the former in the form of the second abdominal sternite; differs from the latter in the darker wings, the stronger development of the hypopygial carina, and the larger size.

### SQUAMULOTILLA SUBDEBILIS sp. nov.

*Male.*—Entirely black, except the legs dark brown, clothed throughout with sparse, pale pubescence, thickest on the mesopleuræ; lateral margins of pronotum sinuate, the humeral angles dentate; first abdominal segment without a median, longitudinal carina; hypopygium with a very feeble, transverse carina near the proximal margin; wings subhyaline, with two cubital cells, only $R_4$ absent. Length, 5 millimeters.

Head entirely black, clothed throughout with sparse, pale pubescence; mandibles subacute at the apex and with two small teeth within near the apex; median area of clypeus slightly, convexly elevated, with fine, close punctures, the anterior margin distinctly concave; antennal tubercles distinctly separated; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum equal in length to the second; antennal scrobes carinate above; front with small, distinct, separated punctures, the vertex and genæ with small, close, confluent punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax at the tegulæ, 2.1 : 2.1.

Thorax entirely black, clothed throughout with sparse, pale pubescence, thickest on the mesopleuræ; lateral margins of pronotum slightly sinuate, the humeral angles produced into a small, acute tubercle; pronotum and mesonotum with small, close, distinct punctures; scutellum with small, close, somewhat confluent punctures, with only a faint indication of a median, longitudinal furrow; dorsum and posterior face of propodeum shallowly, distinctly reticulate, the reticulations on the dorsum much broader than on the posterior face and inclosing fine punctures, the lateral margins of the posterior face not well defined; anterior margin of propleuræ defined by a carina, the propleuræ obscurely punctate; mesopleuræ elevated ventrally and dorsally, the elevations separated by a furrow, the ventral elevation with fine, sparse punctures, the dorsal elevation with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum punctate-reticulate; tegulæ small, convex, with small, sparse punctures and sparse, pale pubescence.

Abdomen entirely black, clothed throughout with sparse, pale pubescence; first tergite with fine, sparse punctures; second tergite with small punctures, sparse medially and posteriorly, becoming close laterally and anteriorly; tergites three to six with small, distinct, separated punctures; last tergite with small, close punctures, except along the median, longitudinal line; first sternite without a median, longitudinal carina; second sternite with a very feeble, median, longitudinal carina on the anterior half, with small, close punctures becoming sparser anteriorly and laterally; sternites three to six with small, close, distinct punctures; hypopygium with a feeble, transverse carina near the proximal margin, with inconspicuous fine punctures posterior to the carina.

Legs dark brown, finely punctate and clothed with sparse, pale pubescence; calcaria pale.

Wings subhyaline; cell 2d $R_1 + R_2$ large, twice as long as broad; two cubital cells present, $R_5$ small, only $R_4$ absent; vein $M_2$ indistinct, uniting with vein $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—LUZON, male, Los Baños, 1917 (*F. X. Williams*), in collection of University of Minnesota.

*Paratype.*—LUZON, male, Los Baños, 1917 (*F. X. Williams*).

Related to *roxane* but differs in the weakly developed hypopygial carina, the lighter wings, sculpturation of the propodeum, and smaller size.

**SQUAMULOTILLA SULPICILLA** sp. nov.

*Male.*—Head black, thorax ferruginous, abdomen with violaceous reflections, coxæ and trochanters pale ferruginous, remainder of legs black, clothed throughout with sparse, pale pubescence, except the last two abdominal segments with fuscous pubescence; lateral margins of pronotum distinctly sinuate; posterior face of propodeum separated from the sides by a thin, elevated carina; first abdominal sternite without a median, longitudinal carina; hypopygium with only a feeble, transverse carina near the proximal margin; wings subhyaline, with two cubital cells, only $R_4$ absent. Length, 6 millimeters.

Head entirely black, clothed throughout with sparse, pale pubescence; mandibles subacute at the tips and with two small teeth within near the apex; clypeus with a small, triangular, convexly elevated area, the latter with fine, close punctures, and with the anterior margin slightly concave; antennal tubercles very distinctly separated; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum distinctly shorter than the second; antennal scrobes distinctly carinate above; front with small, distinct, separated punctures, the vertex and genæ with small, close punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 2.5 : 2.5.

Thorax entirely ferruginous, sparsely clothed with pale pubescence, erect and recumbent on the pronotum and mesonotum, erect and long on the dorsum and posterior face of propodeum, and thickest on the mesopleuræ; lateral margins of pronotum distinctly sinuate, the humeral angles sharply dentate; pronotum, mesonotum and scutellum with moderate, close, somewhat, confluent punctures; dorsum and posterior face of propodeum shallowly, distinctly reticulate, the dorsum without an inclosed space, the lateral margins of the posterior face defined by a high, thin carina, the latter not uniform in height; anterior margin of propleuræ defined by a prominent, sharp carina, the propleuræ obscurely punctate; mesopleuræ elevated ventrally and dorsally, the elevated areas separated by a furrow, the ventral area with fine, sparse punctures, the dorsal area with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum reticulate; tegulæ small, convex, with sparse, fine punctures, and sparse, pale pubescence.

Abdomen dark, with violaceous reflections, clothed with sparse, pale pubescence, except the last two segments with fuscous pubescence; first tergite with fine, sparse punctures; second tergite with small, sparse punctures, the latter becoming fine and scattered posteriorly; tergites three to six with small, sparse punctures; last tergite with small, close punctures, except along the median line; first sternite without a median, longitudinal carina; second sternite with a feeble, median, longitudinal carina on the anterior half, with small, distinct, sparse punctures throughout; sternites three to six with small, close but distinct punctures; hypopygium with a feeble, transverse carina near the proximal margin and with fine, sparse punctures posterior to the carina.

Coxæ and trochanters pale ferruginous, the remainder of legs blackish, finely punctured and clothed with sparse, pale pubescence; calcaria pale.

Wings subhyaline; cell 2d $R_1 + R_2$ large, slightly more than twice as long as broad; two cubital cells present, $R_5$ small and pentagonal; vein $M_2$ indistinct, received by vein $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—Male, catalogue No. 49325, United States National Museum, MINDANAO, Dapitan (*Baker*).

*Paratypes.*—MINDANAO, two males, Dapitan (*Baker*).

Differs from all the preceding species with two cubital cells, in the ferruginous thorax, the strongly sinuate lateral margins of the pronotum, and the conspicuously defined lateral margins of the posterior face of propodeum. Also related to *teuta* but differs from that species in the defined margins of the posterior face of propodeum, the much more sparsely punctured body, and the weakly developed hypopygial carina.

### SQUAMULOTILLA TEUTA subsp. TEUTA sp. et subsp. nov. Plate 1, fig. 2.

*Male.*—Head, abdomen, legs, and tegulæ black, the mandibles, lateral areas of clypeus and thorax entirely, ferruginous, clothed throughout with sparse, pale pubescence, except the last two abdominal segments with fuscous pubescence; lateral margins of pronotum slightly sinuate; lateral margins of posterior face of propodeum not defined; first abdominal sternite without a median, longitudinal carina; second sternite with a transverse, gibbose, subapical ridge; hypopygium with a conspicuous, transverse, arcuate carina near the proximal margin; wings subfuscous, with two cubital cells, only $R_4$ absent. Length, 7 millimeters.

Head black, except the mandibles and lateral areas of clypeus, ferruginous, clothed throughout with sparse, pale pubescence;

mandibles subacute at the tips and with two small teeth within near the apex; median triangular area of clypeus elevated, black, with fine, close punctures and sparse, pale pubescence, the anterior margin slightly concave; antennal tubercles almost contiguous; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum almost equal in length to the second; antennal scrobes distinctly carinate above; front with small, close, scarcely confluent punctures, the vertex and genæ with small, dense punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 2.7 : 2.7.

Thorax entirely ferruginous except the tegulæ, blackish; lateral margins of pronotum slightly sinuate, the humeral angles, angulate; pronotum, mesonotum and scutellum with moderate, very close, confluent punctures; dorsum and posterior face of propodeum, shallowly, distinctly reticulate, the dorsum without an inclosed space, the lateral margins of the posterior face not defined; anterior margin of propleuræ defined by a carina, the propleuræ obscurely punctate; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by a furrow, with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum reticulate posteriorly; tegulæ small, glabrous, convex, with small, scattered punctures and sparse, pale pubescence.

Abdomen entirely black, except first sternite ferruginous; clothed with sparse, pale pubescence, except the last two segments with fuscous pubescence; first tergite with sparse, small punctures; second tergite with sparse, small punctures becoming closer at the anterior margin, sparser and smaller towards the posterior margin; tergites three to six with small, distinct, separated punctures; last tergite with small, close, confluent punctures; first sternite without a median, longitudinal carina; second sternite with a feeble, longitudinal, median carina on the anterior two-thirds, and a transverse, subapical, gibbose ridge extending from one side to the other, with small, distinct, separated punctures throughout; sternites three to six with small, close, distinct punctures; hypopygium with a conspicuous, transverse, arcuate carina near the proximal margin, and with fine, close punctures posterior to the carina.

Legs entirely black, finely punctured and clothed with sparse, pale pubescence; calcaria pale.

Wings subhyaline; cell 2d $R_1 + R_2$ large, twice as long as broad; two cubital cells present, $R_5$ small, pentagonal, $R_4$ entirely absent; vein $M_2$ received by vein $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—Male, catalogue No. 49326, United States National Museum, LUZON, Los Baños (*Baker*).

*Paratypes.*—LUZON, 3 males, Los Baños, July–August, 1917 (*F. X. Williams*); male, Los Baños (*Baker*); two males, Mount Maquiling (*Baker*).

Related to *sulpicilla* but differs in having the lateral margins of propodeum undefined, in the conspicuous, arcuate carina of the hypopygium, and in the gibbose ridge of the second sternite.

Three of the paratypes from Los Baños have the thorax entirely ferruginous like the type; the two from Mount Maquiling have the scutellum black; and one from Los Baños has both the mesonotum and the scutellum entirely black.

### SQUAMULOTILLA TEUTA subsp. VICINARIA subsp. nov.

*Male.*—Exactly like *teuta* subsp. *teuta*, except the thorax black, with only the metapleuræ and propodeum ferruginous.

*Holotype.*—Male, catalogue No. 49327, United States National Museum, NEGROS, Cuernos Mountains (*Baker*).

*Paratype.*—NEGROS, Cuernos Mountains (*Baker*).

Very close to subsp. *teuta* from Luzon, differing only in the black coloration of the prothorax and mesothorax. Certain Luzon specimens show a tendency to develop black on the notal areas, and the Negros specimens show this fully developed in the two anterior segments of the thorax. The holotype and the paratype are alike in coloration.

### SQUAMULOTILLA EMINULA sp. nov.

*Male.*—Head and legs black, thorax except the metapleuræ and propodeum entirely ferruginous, abdomen dark metallic blue, except the median posterior margin of the second tergite, yellowish; lateral margins of pronotum slightly angulate medially; first sternite with a distinct, median, longitudinal carina; hypopygium with a pair of low, obscure tubercles, one at each anterolateral angle; wings subfuscous, with two cubital cells, only $R_4$ absent. Length, 11 millimeters.

Head entirely black, except the distal half of mandibles, dark ferruginous, clothed with sparse, pale pubescence, thickest on the genæ; mandibles acute at the tips and with two small teeth within near the apex; median, triangular area of clypeus slightly elevated, with fine, close punctures, and the anterior margin slightly concave; antennal tubercles slightly separated; scape finely, closely punctured and with sparse, pale pubescence; first segment of flagellum distinctly shorter than the second; antennal scrobes distinctly carinate above; front with small, distinct separated punctures, the vertex and genæ with small, close, somewhat confluent punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 3.7 : 4.0.

Thorax black, except the metapleuræ and propodeum entirely ferruginous, clothed with sparse, pale pubescence, thickest on the mesopleuræ; lateral margins of pronotum slightly angulate medially, the humeral angles angulate; pronotum and mesonotum with moderate, very close but mostly distinct punctures; scutellum with moderate, more or less confluent punctures and with an obscure, median, longitudinal furrow; dorsum and posterior face of propodeum shallowly but distinctly reticulate, the dorsum without an inclosed space and the lateral margins of the posterior face not defined; anterior margin of propleuræ defined by a carina, the propleuræ with very fine, close punctures; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by a furrow, the ventral area with small, sparse, and fine, close punctures intermixed, the dorsal area with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum reticulate posteriorly; tegulæ convex, with small, separated punctures, and sparse, pale pubescence.

Abdomen dark metallic blue, except the median, apical margin of the second tergite, yellowish, clothed with sparse, pale pubescence, except the last two segments with fuscous pubescence; first tergite with very small, sparse punctures throughout; second tergite with small, sparse punctures becoming very small and close at the anterior margin; tergites three to six with small, sparse punctures; last tergite with small, close punctures except along the median line; first sternite with a distinct, median, longitudinal carina; second sternite with a feeble, longitudinal, median carina on the anterior third, and with moderate, distinct, separated punctures; sternites three to six with moderately small, distinct, mostly separated punctures; hypopygium with very small, sparse punctures, and with a pair of low, obscure tubercles, one at each anterolateral angle.

Legs entirely black, finely punctuate and clothed with sparse, pale pubescence; calcaria pale.

Wings subfuscous; cell 2d $R_1 + R_2$ large, slightly more than twice as long as broad; two cubital cells present, $R_5$ small and pentagonal, $R_4$ entirely absent; vein $M_2$ received by vein $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—Male, catalogue No. 49328, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, male, Los Baños, July–August, 1917 (*F. X. Williams*); 2 males, Los Baños, September, 1917 (*F. X. Williams*); male, Los Baños (*Baker*); male, Los Baños (*G. Villegas*); 7 males, mount Maquiling (*Baker*).

This species differs from all the preceding males in having a distinct, median, longitudinal carina on the first sternite; its large size, coloration of the thorax, and the narrow, yellowish, transverse stripe at the apical margin of the second tergite will also aid in its recognition.

### SQUAMULOTILLA UMBROSA sp. nov.

*Male.*—Entirely black with obscure metallic blue reflections, except the distal half of mandibles dark ferruginous, clothed throughout with sparse, pale pubescence except the last two abdominal segments with fuscous pubescence; first segment of flagellum equal in length to the second; lateral margins of pronotum distinctly sinuate; first abdominal sternite with a distinct, median, longitudinal carina; hypopygium with a pair of low, obscure tubercles, one at each anterolateral angle; wings subfuscous, with two cubital cells, only $R_4$ absent. Length, 11 millimeters.

Head entirely black with obscure metallic blue reflections, except distal half of mandibles dark ferruginous, clothed throughout with sparse, pale pubescence; mandibles subacute at the tips and with two small teeth within near the apex; median, triangular area of clypeus convexly elevated, with intermixed fine and small, close punctures, the anterior margin of the area slightly concave, and the anterior angles prominent; antennal tubercles slightly but distinctly separated; scape with fine, close punctures and sparse, pale pubescence; first segment of flagellum equal in length to the second; antennal scrobes carinate above; front with moderate, close but distinctly separated punctures; vertex and genæ with moderate, very close, confluent punctures; genæ rounded posteriorly, the posterior margin not defined; relative widths of head and thorax including the tegulæ, 3.8 : 4.2.

Thorax entirely black with obscure, metallic blue reflections, clothed throughout with sparse, pale pubescence, erect and recumbent on the pronotum and mesonotum, erect and long on the propodeum, thickest on the mesopleuræ; lateral margins of pronotum distinctly sinuate, with an angulate tubercle medially, and the humeral angles strongly angulate; pronotum, mesonotum, and scutellum with moderate, very close, confluent punctures, the scutellum without a longitudinal furrow; dorsum and posterior face of propodeum shallowly, distinctly reticulate, the dorsum without an inclosed space, the lateral margins of the posterior face not defined; anterior margin of propleuræ defined by a prominent carina, the latter elevated into a distinct tubercle medially, the propleuræ with very fine, close punctures; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by a furrow, the ventral area with intermixed small and fine punctures, the dorsal area with small, close punctures; metapleuræ glabrous, impunctate; sides of propodeum reticulate posteriorly; tegulæ convex, with small, close punctures and sparse, pale pubescence.

Abdomen entirely black with obscure metallic blue reflections, clothed with sparse, pale pubescence, except the last two segments with fuscous pubescence; first tergite with very small, sparse punctures; second tergite with small, sparse punctures throughout except the anterior two-thirds of the lateral margins finely, closely punctate; tergites three to six with small, sparse punctures; last tergite with small, close punctures; first sternite with a distinct, median, longitudinal carina; second sternite with a feeble, median, longitudinal carina on the anterior two-thirds and with moderately small, close, occasionally confluent punctures throughout; sternites three to six with small, close distinct punctures; hypopygium with a pair of low, obscure tubercles, one at each anterolateral angle, and with fine punctures posterior to the carina.

Legs entirely black, finely punctured and sparsely clothed with pale pubescence, the latter thickest on the tibiæ; calcaria pale.

Wings subfuscous, the costal area of cell 2d $R_1 + R_2$ darker, the latter large, slightly more than twice as long as broad; two cubital cells present, $R_5$ small and pentagonal, $R_4$ entirely absent; vein $M_2$ received by vein $M_{1+2}$ considerably beyond the apex of cell $R_5$.

*Holotype.*—Male, catalogue No. 49329, United States National Museum, LUZON, Mount Banahao (*Baker*).

*Paratype.*—LUZON, male, Mount Maquiling (*Baker*).

Related to *eminula.* Differs in having the first segment of flagellum equal in length to the second, the distinctly sinuate lateral margins of pronotum, the entirely black color, and subtle differences in puncturation.

## Genus ODONTOMUTILLA Ashmead

*Key to the species.*

MALES

1. Posterolateral angles of dorsum of propodeum produced, prominently angulate; ventral third of mesopleuræ, ventral half of metapleuræ, and propodeum entirely, black........................................ *familiaris* (Smith).

   Posterolateral angles of dorsum of propodeum not at all produced, evenly rounded; thorax entirely ferruginous........................................ 2.

2. Femora mostly black, only the proximal fourth ferruginous; second tergite with moderate, distinct punctures throughout the discal area; pale pubescent band of third tergite narrowly interrrupted medially. *andromeda* sp. nov.

   Femora entirely ferruginous; second tergite with the discal area glabrous, sparsely punctate; pale pubescent band of third tergite complete ........................................ *pedaria* sp. nov.

FEMALES

1. Second tergite with a large, anterolateral pubescent fovea; legs entirely black ........................................ *familiaris* (Smith).

   Second tergite without any such fovea; at least the femora in part ferruginous ........................................ 2.

2. Basal two-thirds of second tergite with moderate, confluent punctures; scape and legs entirely ferruginous........................................ *pedaria* sp. nov.

   Basal two-thirds of second tergite with fine, dense, more or less confluent punctures; coxæ, trochanters, and proximal two-thirds of femora ferruginous; remainder of legs and scape entirely, black. *andromeda* sp. nov.

### ODONTOMUTILLA FAMILIARIS (Smith).

1858. *Mutilla familiaris* SMITH, Journ. Proc. Linn. Soc., Zool. 2: 84, female.
1897. *Mutilla familiaris* DALLE TORRE, Cat. Hymen. 8: 39, female.
1903. .................... *familiaris* ANDRÉ, Gen. Ins. 1, fasc. 11: 70, female.

*Holotype.*—Female, Singapore, Malay Peninsula, in Saunders's collection, Oxford University, England.

The description of the male, which is heretofore undescribed, is as follows:

*Male.*—Head, abdomen, and legs black, the thorax bright ferruginous except the sternum, ventral third of mesopleuræ, ventral half of metapleuræ and propodeum entirely, black; posterolateral angles of dorsum of propodeum prominently angulate; third abdominal tergite clothed with dense, appressed, pale pubescence, the latter narrowed and broadly interrupted medially; wings very dark fuscous. Length, 16 millimeters.

Head entirely black, the front and vertex clothed with sparse, erect, obscure ferruginous pubescence, the remainder of the head clothed with sparse, erect, pale pubescence; mandibles not excised beneath, edentate at the apices and with a distinct tooth within near the apex; median triangular area of clypeus elevated, the anterior margin defined by a narrow, glabrous rim, the contour of the elevation from anterior to posterior margins almost evenly convex, the elevation with a pair of median, approximate, distinct tubercles, and the posterior half of the elevation densely, shallowly, confluently punctate; antennal tubercles connected by a distinct carina slightly angulate at the median line; scape weakly bicarinate beneath, above with close, intermixed small and moderate punctures; first segment of flagellum approximately one-half the length of the second; antennal scrobes strongly carinate above; front, vertex, and genæ coarsely, confluently punctate, the posterior margin of the latter defined by a distinct, sharp carina; gular margins carinate, the carinæ elevated into a distinct tooth a short distance posterior to the insertion of the mandibles; relative widths of head and thorax including the tegulæ, 4.4: 7.0.

Thorax bright ferruginous, except the sternum, ventral third of mesopleuræ, ventral half of metapleuræ and propodeum entirely, black, the ferruginous areas clothed with sparse, erect, ferruginous pubescence, the black areas clothed with sparse, erect, pale pubescence and very short, inconspicuous, subappressed, pale pubescence; pronotum, mesonotum, and scutellum with dense, coarse, confluent punctures; humeral angles acute, subdentate, the lateral margins of pronotum sinuate; mesonotum with a median, longitudinal carina, the parapsidal furrows obsolete; scutellum depressed along the median longitudinal line, the posterolateral angles slightly, bluntly produced; propleuræ with the anterior margin defined by a strong, sharp carina, the strongly depressed ventral third of propleuræ separated from the dorsal two-thirds by a strong transverse oblique carina; propleuræ micropunctate with a few, shallow, large punctures dorsally; mesopleuræ evenly convex throughout, the anterior fifth micropunctate, the remainder coarsely, deeply, confluently punctate; metapleuræ for the most part micropunctate, ventrally with large, shallow, confluent punctures; posterolateral angles of dorsum of propodeum prominently and angulately produced, the tip of the process forming approximately a right angle; dorsum and posterior faces of propodeum otherwise rounded into one another, broadly and deeply reticulate; sides of propodeum much more narrowly and shallowly reticulate than the dorsal and posterior faces, except the anterior fourth micropunctate;

tegulæ very large, equal in length to three-fourths the length of the mesonotum, ferruginous, clothed with sparse, ferruginous pubescence, micropunctate and also with scattered, shallow, moderate, inconspicuous punctures.

Abdomen entirely black; first segment, anterior third of second tergite and second sternite entirely with sparse, erect and suberect, pale pubescence; posterior two-thirds of second tergite with sparse, fuscous pubescence; third tergite with dense, appressed, pale pubescence narrowed and broadly interrupted medially; apical fringes of second and third sternites pale and the posterolateral angles of the same sternites with small spots of dense, appressed, pale pubescence; remainder of abdomen with sparse, black pubescence; anterior face of first tergite with large, close punctures, the anterior half of dorsal face of same tergite with large, dense, confluent punctures, the posterior half glabrous, impunctate; second tergite with large close punctures anteriorly and laterally, the punctures becoming moderately small and somewhat separated posteriorly, the disk glabrous, impunctate; third tergite with moderately small punctures anteriorly, fine, close punctures beneath the dense, pale pubescence, and scattered, small punctures medially; tergites four to six with moderate, separated punctures, those on six closer and denser than on four and five, the latter with the punctures sparse at the median line, and all three with a broad, posterior margin glabrous, impunctate; last tergite with moderate, dense, confluent punctures throughout; first sternite with a median, longitudinal carina, the proximal and distal ends of the carina moderately elevated; second sternite with a low, median, longitudinal carina on the anterior third, with large, distinct punctures throughout, sparsest at the median, lateral areas, and becoming small and close at the posterior margin; sternites three to six with moderate punctures, separated laterally, close medially; hypopygium broader than long with moderate, close punctures.

Legs entirely black, clothed throughout with moderately thick, appressed and erect pubescence; calcaria pale.

Wings very dark fuscous; cell 2d $R_1 + R_2$ broadly, squarely truncate at the apex; cell $R_5$ receiving vein $M_{3+4}$ at the middle; cell $R_4$ obsolete.

*Allotype.*—MINDANAO, male, Dapitan (*Baker*), in United States National Museum.

Specimens examined: LUZON, female, Los Baños (*Baker*); 3 females, 4 males, Mount Maquiling (*Baker*); female, Lamao, 1912 (*C. S. Banks*); male, Bangui, November, 1923. SAMAR, 3 females, 8 males (*Baker*). NEGROS, female, Cuernos Mountains (*Baker*); female, Nakalang, February 25, 1902. MINDANAO, 3 males, Surigao (*Baker*); male, 2 females, Surigao; male, Butuan (*Baker*); male, Tangkulan, Bukidnon (*Baker*); 2 males,, 2 females, Bukidnon Province, June 3, 1931 (*L. H. Philips*); 4 males, Iligan (*Baker*); female, male, Kolambugan, 1914 (*C. S. Banks*); 2 females, 4 males, Kolambugan (*Baker*); 3 males, Dapitan (*Baker*); female, 4 males, Davao (*Baker*); female, 2 males, Zamboanga (*Baker*); 2 males, Momungan. BASILAN, 3 males (*Baker*).

I have examined the holotype of this species at Oxford and can find no differences between it and the Philippine specimens; Borneo material is also identical with the holotype and with the Philippine material. I have had the opportunity of examining two collections of material from the Malay Peninsula which contained a number of specimens of this genus but found no representatives of this species in the two collections. The holotype remains a unique specimen as far as Malaya is concerned. There is a remote possibility that the locality has been cited incorrectly in the original description although the label on the specimen agrees with that in the description; that is, "Singapore." The female specimens from the Philippines vary in having the pale pubescent band of the third tergite uninterrupted in some, narrowly interrupted in others. The males vary in length from 10 to 16 millimeters.

### ODONTOMUTILLA PEDARIA sp. nov.

*Male.*—Head, abdomen, tibiæ, and tarsi black; thorax, coxæ, trochanters, and femora ferruginous; third tergite with a complete, broad band of pale pubescence; disk of second tergite very sparsely punctate, glabrous, laterally and anteriorly with close punctures; proximal half and apical sixth of wings hyaline, the remainder subfuscous with a dark cloud in cells $R + 1st\ R_1$ and $2d\ R_1 + R_2$. Length, 7 millimeters.

Head entirely black, except the tip of the scape and the pedicel obscurely ferruginous, clothed throughout with sparse, erect, pale pubescence; mandibles edentate at the tip and with a small tooth within near the apex; median triangular area of clypeus elevated, the anterior half glabrous, impunctate, and with a transverse furrow, the posterior half densely, confluently punctate; scape with a single carina beneath, clothed with short, thick, pale pubescence; first segment of flagellum approximately one-half the length of the second; front, vertex, and genæ with large, dense, more or less confluent punctures, the genæ defined posteriorly by a distinct, sharp carina; gular margins distinctly carinate and elevated into a distinct tooth a short distance posterior to the insertion of the mandibles; relative widths of head and thorax including the tegulæ, 2.6 : 2.9.

Thorax entirely ferruginous, the pronotum, mesonotum, and scutellum clothed with sparse, ferruginous pubescence, the remainder of the thorax with sparse, pale pubescence; pronotum, mesonotum, and scutellum with moderate, dense punctures, confluent on the pronotum and scutellum, distinct on the mesonotum; humeral angles angulate, not prominent; lateral margins of pronotum straight; parapsidal furrows of mesonotum obsolete; posterolateral angles of scutellum produced into a short, subspinose process; posterolateral angles of dorsum of propodeum not at all produced, evenly rounded into the posterior face, the latter and the dorsum of propodeum broadly, deeply reticulate; propleuræ micropunctate, the anterior margin defined by a distinct, sharp carina; mesopleuræ evenly convex, the anterior fourth micropunctate, the remainder with large, shallow, close punctures; metapleuræ glabrous, impunctate except ventrally with shallow, indistinct punctures; anterior fourth of sides of propodeum glabrous, weakly micropunctate, the remainder narrowly, shallowly reticulate; tegulæ large, slightly longer than two-thirds the length of the mesonotum, ferruginous, with moderate, scattered punctures and sparse, ferruginous pubescence.

Abdomen black, except the first sternite and anterior margin of first tergite ferruginous, clothed throughout with sparse, erect, inconspicuous, pale pubescence; anterior face of first tergite with large, scattered punctures, the dorsal face glabrous, except a transverse row of moderate, deep, confluent punctures at the anterior margin; second tergite with moderate punctures, separate and distinct anteriorly, becoming close laterally, and close and smaller posteriorly except the disk very sparsely punctate, almost impunctate; third tergite with small, distinct punctures, and with a band of dense, appressed, pale pubescence, somewhat narrowed medially but complete; tergites four to six with small, close, distinct punctures, except the broad posterior margin of each glabrous, impunctate; last tergite with small, dense, confluent punctures throughout; first sternite with a distinct, median, sharp carina somewhat elevated posteriorly; second sternite with an obscure, median, longitudinal carina on the anterior third, and with moderate, distinct punctures throughout, sparser on the anterior median area than elsewhere; sternites three to six with small, close punctures; hypopygium with small, dense, confluent punctures throughout.

Coxæ, trochanters, and femora ferruginous, the tibiæ and tarsi blackish; legs clothed with moderately thick, erect and appressed, pale pubescence; calcaria pale.

Proximal half and apical sixth of wings hyaline, the remainder subfuscous with a dark cloud in cells R + 1st $R_1$ and 2d $R_1 + R_2$, the latter rounded at apex, not at all truncate; cell $R_5$ receiving vein $M_{3+4}$ at one-third the distance from base to apex; cell $R_4$ entirely absent; veins m-cu and $M_{3+4}$ parallel.

*Female.*—Head and abdomen black, the scape, thorax, and legs entirely ferruginous; third abdominal tergite with a complete, uninterrupted band of pale pubescence; anterior two-thirds of second tergite with moderate, dense, confluent punctures, the latter becoming small and close on the posterior third, the distal margin of the tergite glabrous, impunctate; second tergite without a pubescent fovea at the anterolateral angles. Length, 6 millimeters.

Head black, except the scape, pedicel and flagellum beneath, ferruginous; front and vertex clothed with sparse, erect and suberect, dark fuscous pubescence, the genæ with sparse, pale pubescence; mandibles slender, edentate at the tip and with a small tooth within near the apex; median triangular area of clypeus elevated, the anterior half glabrous, impunctate and bounded posteriorly by a carina interrupted medially, the posterior half with a prominent, short, subarcuate carina midway between the interrupted carina and the apex of the triangular median area; scape not carinate beneath, with fine, close punctures, and short, sparse, pale pubescence; first segment of flagellum slightly shorter than the second, distinctly so when viewed from beneath; antennal scrobes strongly carinate above, the carinæ connected by a transverse carina joining the antennal tubercles; front, vertex, and genæ with moderately coarse, dense, confluent punctures, the posterior margin of the genæ defined by a strong carina; gular carina strong and elevated posterior to the insertion of the mandibles into a distinct tooth; relative widths of head and thorax, 2.5 : 2.6.

Thorax entirely ferruginous, the dorsum clothed with sparse, erect and recumbent, ferruginous pubescence, the sides with scattered, erect, pale hairs and inconspicuous, pale micropubescence; humeral angles angulate but not prominent; lateral margins of pronotum with a blunt tubercle just posterior to the humeral angles; lateral margins of mesonotum broadly angulate anteriorly, the thorax widest at this angulation, and with the sides gradually converging posterior to this angle; dorsum of thorax with moderate, dense, confluent punctures; scutellar scale entirely absent; anterior half of posterior face of propodeum coarsely rugose, the posterior half with scattered, moderate punctures; lateral margins of posterior face of propodeum slightly denticulate anteriorly; propleuræ closely micropunctate, the anterior margin defined by a strong carina; mesopleuræ with a distinct, well-defined, ventrodorsal ridge terminating dorsally at the apex of the angle in the lateral margins of mesonotum; mesopleural area posterior to the ridge and the metapleural area, glabrous, impunctate; sides of propodeum glabrous, with a few, scattered, small, indistinct punctures.

Abdomen black, except the first sternite and the anterior margin of the first tergite, ferruginous; anterior face of first tergite with moderate, elongate, close, somewhat confluent punctures, clothed with sparse, erect, pale hairs, and sparse, recumbent, fuscous pubescence; anterior half of dorsal face of first tergite with moderate, dense, confluent punctures, and sparse, erect, fuscous pubescence, the posterior half glabrous, impunctate; anterior two-thirds of second tergite with moderate, dense, confluent punctures, the latter becoming small and close on the posterior third, the distal margin of the tergite glabrous; second tergite clothed with sparse, erect and recumbent, blackish pubescence, except the lateral fourths with sparse, pale pubescence; third tergite with small, close, shallow punctures anteriorly, and with a broad, complete band of dense, appressed, pale pubescence; tergites four and five with small, shallow, close, somewhat confluent punctures, except the broad, distal margin of each, glabrous and impunctate, clothed with sparse, erect and recumbent, fuscous pubescence; last tergite rugose-punctate throughout, clothed with sparse, pale pubescence; first sternite with a median, longitudinal carina elevated posteriorly into a small tooth; second sternite with moderate, distinct, well-separated punctures, sparser medially, clothed with very sparse, pale pubescence and with a thin, apical fringe of pale hairs; sternites three to five with small, close punctures and each with a thin, apical fringe of pale hairs; hypopygium with small, close, distinct punctures and sparse, erect, pale hairs.

Legs entirely ferruginous, the tarsi slightly darker than the remainder of the legs, clothed with erect and appressed, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49330, United States National Museum, MINDANAO, Iligan (*Baker*).

*Allotype.*—MINDANAO, female, Iligan (*Baker*), in United States National Museum.

*Paratypes.*—MINDANAO, 5 females, Surigao (*Baker*); female, Surigao; 4 males, 4 females, Iligan (*Baker*); 15 males, 7 females, Kolambugan (*Baker*); 2 females, Dapitan (*Baker*); 3 males, 2 females, Zamboanga (*Baker*). BASILAN, male, 4 females (*Baker*). PALAWAN, female (*Baker*).

Closely related to *cassiope* Smith from Borneo. The female differs from that species in having the legs entirely ferruginous, and in the denser, coarser puncturation of the second tergite. The male of *cassiope* is undescribed.

### ODONTOMUTILLA ANDROMEDA sp. nov.

*Male.*—Head, abdomen, distal three-fourths of femora, tibiæ and tarsi, black; thorax, coxæ, trochanters, and proximal fourth of femora, ferruginous; second abdominal tergite with moderate punctures throughout; third abdominal tergite with a broad band of dense, appressed, pale pubescence, narrowly subinterrupted at the middle; proximal half of wings hyaline, the distal half subfuscous, cells R + 1st $R_1$ and 2d $R_1 + R_2$ with a darker cloud. Length, 7.5 millimeters.

Head entirely black, clothed throughout with sparse, erect and suberect, pale pubescence; mandibles edentate at the tip and with a small tooth within near the apex; median, triangular area of clypeus elevated, with a broad, transverse, glabrous groove anteriorly, posteriorly densely, finely, confluently punctate; scape not carinate beneath, with fine, close punctures and sparse, pale pubescence; tip of scape, and pedicel obscurely ferruginous; first segment of flagellum approximately three-fourths the length of the second; antennal scrobes distinctly carinate above; front, vertex, and genæ with moderately large, dense, shallow, confluent punctures, the posterior margin of genæ defined by a distinct carina; gular carinæ distinct, elevated into a small, distinct tooth, posterior to the insertion of the mandibles; relative widths of head and thorax, including the tegulæ, 2.9 : 3.3.

Thorax entirely ferruginous, the pronotum, mesonotum, and scutellum clothed with sparse, erect and recumbent, ferruginous pubescence, the dorsum and posterior face of propodeum with sparse, long, erect, pale hairs, elsewhere with sparse, pale pubescence; humeral angles angulate but not prominent; lateral margins of pronotum straight; pronotum, mesonotum, and scutellum with moderately large, dense, deep, confluent punctures; parapsidal furrows entirely obsolete; posterolateral angles of scutellum slightly, angulately produced; posterolateral angles of dorsum of propodeum not at all produced, evenly rounded into the posterior face, the latter and the dorsum of propodeum broadly reticulate throughout; propleuræ closely micropunctate and micropubescent, the anterior margin defined by a strong, sharp carina; mesopleuræ evenly convex throughout, the anterior fifth micropunctate, the remainder with moderate, shallow, close, somewhat confluent punctures; metapleuræ glabrous, indistinctly micropunctate, except ventrally with large, shallow, confluent punctures; anterior fifth of sides of propodeum glabrous, the remainder narrowly, shallowly reticulate; tegulæ large, their length approximately two-thirds the length of the mesonotum, the disk with moderate, dense, confluent punctures, the margins impunctate.

Abdomen entirely black; anterior face of first tergite with large, scattered punctures and sparse, erect, pale hairs; dorsal face of first tergite with a row of moderate, dense, confluent punctures at the anterior margin, the remainder of the dorsal face glabrous, impunctate; second tergite with moderately large, somewhat shallow, separated punctures, becoming closer laterally, closer and smaller posteriorly, but with no impunctate area on the disk, very sparsely clothed with erect, pale hairs and recumbent, short, blackish pubescence; third tergite with small, close punctures anteriorly, and with a broad, band of dense, appressed, pale pubescence, the latter narrowly subinterrupted medially (that is, appearing to be interrupted, but under the microscope the interrupted area is seen to have pale pubescence but much thinner and sparser than the band itself); tergites four to six with small, close, distinct punctures, except the broad, distal margin of each tergite glabrous, impunctate, clothed with sparse, erect and recumbent black pubescence, except the erect hairs of the fourth and fifth segments pale in certain lights; last tergite with small, dense, confluent punctures; first sternite with a high, thin, translucent carina; elevated anteriorly and posteriorly; second sternite with an obscure, median, longitudinal carina on the anterior fourth, with moderate, close, distinct punctures, and very sparse, erect, pale hairs, as well as a thin apical fringe of pale hairs; tergites three to six with small, close punctures, and each with a thin, apical fringe of pale hairs; hypopygium with small, dense, deep, confluent punctures.

Coxæ, trochanters, and proximal fourth of femora ferruginous; distal three-fourths of femora, tibæ and tarsi, black, except the ferruginous of the femora suffused into the black, and the definite amount of ferruginous or black can only be approximated; legs clothed throughout with sparse, erect and appressed, pale pubescence; calcaria pale.

Proximal half of wings hyaline, the distal half subfuscous, and cells R + 1st $R_1$ and 2d $R_1 + R_2$ with a still darker cloud; cell 2d $R_1 + R_2$ rounded at the apex, not at all truncate; cell $R_5$ receiving vein $M_{3+4}$ just before the middle; cell $R_4$ entirely obsolete; veins m-cu and $M_{3+4}$ parallel.

*Female.*—Head, abdomen, tips of femora, tibiæ, and tarsi black; thorax, coxæ, trochanters, and proximal three-fourths of femora ferruginous; second tergite without a pubescent fovea at the anterolateral angles, with small to fine, dense, confluent punctures throughout; third tergite with a band of dense, appressed, pale pubescence, narrowly but distinctly interrupted medially.

Head entirely black, except the scape beneath, pedicel, and flagellum beneath obscure ferruginous; front and vertex clothed with sparse, erect and recumbent, fuscous pubescence, the genæ with sparse, pale pubescence; mandibles slender, edentate at the tip and with a small tooth within near the apex; median, triangular area of clypeus elevated, with a transverse, glabrous groove anteriorly, a transverse median carina just posterior to the groove (the carina not interrupted medially as in *pedaria*) and a prominent, transverse, arcuate carina near the apex posteriorly; scape not carinate beneath, with fine, close punctures and sparse, short, pale pubescence; first segment of flagellum slightly but distinctly longer than the second; antennal scrobes strongly carinate above, the carinæ continuous with a transverse carina connecting the antennal tubercles; front, vertex, and genæ with moderately large, dense, confluent punctures, the posterior margin of the genæ defined by a strong carina; gular margins strongly carinate, the carina elevated into a distinct tooth a short distance posterior to the insertion of the mandibles; relative widths of head and thorax, 2.9 : 3.2.

Thorax entirely ferruginous, the dorsum clothed with sparse, erect and recumbent, ferruginous pubescence, the posterior face of propodeum with scattered, erect, long, pale hairs, and elsewhere with sparse, pale pubescence; humeral angles weakly angulate, the pronotum slightly broadened medially, thus the lateral margins gradually converging posteriorly; dorsum of thorax with moderately large, dense, deep, confluent punctures, becoming longitudinally rugose-punctate posteriorly; scutellar scale entirely absent; anterior portion of posterior face of propodeum coarsely rugose-punctate, the posterior half with scattered, small punctures; anterior margin of propleuræ defined by a strong carina, the propleuræ closely micropunctate and sparsely micropubescent; mesopleuræ with a prominent ridge extending dorsally from the anterior margin of the coxal cavity, the mesopleural area anterior to the ridge closely micropunctate and sparsely micropubescent, the area posterior to the ridge with indistinct, moderate, confluent punctures; metapleuræ glabrous, impunctate, except a few, indistinct punctures ventrally; sides of propodeum glabrous, very obscurely micropunctate and micropubescent; lateral margins of posterior face of propodeum very slightly crenulate.

Abdomen entirely black; anterior face of first tergite with small, more or less close, shallow, elongate punctures and with sparse, long, erect, pale hairs; anterior margin of dorsal face of first tergite with a row of moderate, dense, confluent punctures, and sparse, erect, fuscous hairs, the remainder of the dorsal face glabrous, impunctate; second tergite without a pubescent fovea at the anterolateral angles; with very dense, confluent punctures, small anteriorly, becoming fine posteriorly, laterally the punctures slightly larger, shallower and less dense, clothed with erect and recumbent, sparse, black pubescence, except laterally the pubescence longer and pale; third tergite with small, close to dense punctures, and with a broad band of dense, appressed, pale pubescence, narrowly interrupted medially; tergites four and five with small, dense punctures, except each with a broad, distal margin glabrous, impunctate, clothed with sparse, erect and recumbent, blackish pubescence; lateral areas of last tergite distinctly asperated, the median, distal triangular area granulate; first sternite with a median, longitudinal carina somewhat elevated posteriorly; second sternite with moderate, more or less confluent punctures, clothed with scattered, pale pubescence and with a thin, apical fringe of pale hairs; sternites three to six with moderately small, dense, confluent punctures, and each with a thin, apical fringe of pale hairs; hypopygium with small, close, distinct punctures and sparse, erect, pale hairs.

Coxæ, trochanters, and proximal three-fourths of femora ferruginous, the tips of the femora, tibiæ and tarsi, black; legs clothed with sparse, erect and appressed, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49331, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Allotype.*—LUZON, female, Mount Maquiling (*Baker*), in United States National Museum.

*Paratypes.*—LUZON, female, Los Baños (*Baker*); female, Los Baños; 7 males, 4 females, Mount Maquiling (*Baker*); female, Mount Banahao (*Baker*); male, Limay. SAMAR, female, Catbalogan. NEGROS, female, Cuernos Mountains (*Baker*). MINDANAO, 2 females, Surigao (*Baker*).

Related to *pedaria* and *cassiope*. The female differs from both in the finer, denser puncturation of the second tergite, the interrupted pubescent band of the third tergite, and the asperated pygidium. The male differs from *pedaria* in the evenly distributed puncturation of the second tergite, the subinterrupted pubescent band of the third tergite, and the subfuscous apical area of the wings.

## Genus TIMULLA Ashmead

### Subgenus TROGASPIDIA Ashmead

*Key to the species.*

MALES

1. Hypopygium with lateral, elevated ridges, terminating in a distinct tubercle; scutellum usually distinctly gibbose, rarely not at all gibbose, only slightly convex ........ 2.
   Hypopygium simple, without ridges or tubercles; scutellum not gibbose, only slightly convex ........ 17.
2. Mandibles deeply excised beneath, thus forming a distinct tooth beneath near the base ........ 4.
   Mandibles not excised beneath, without a ventral, basal tooth ........ 3.
3. Abdominal segments two to four, or two to five ferruginous. *philippinensis* subsp. *philippinensis* (Smith).
   Abdomen entirely black ........ *philippinensis* subsp. *itambusa* (Cockerell).
4. Clypeus with a prominent, submarginal carina anteriorly, extending from one side to the other ........ 16.
   Clypeus not transversely carinate anteriorly ........ 5.
5. Last tergite with a broad, median, tumescent, glabrous area, the latter rounded off posteriorly, not terminating in a tubercle ........ 11.
   Last tergite with a narrow, median, glabrous area, the latter not tumescent, but terminating in a low, blunt, distinct tubercle ........ 6.
6. First abdominal segment very dark mahogany red to black, much darker than the second segment, sometimes the posterior third or fourth suffused with ferruginous ........ 7.

First abdominal segment bright ferruginous, concolorous with the second segment ........................................ 8.

7. Abdominal segments two to five entirely ferruginous; hypopygial ridges long, extending onto the posterior half of hypopygium.
*minor* subsp. *princesa* subsp. nov.

Only the second and third abdominal segments ferruginous, remainder of abdomen black; hypopygial ridges short, not extending onto the posterior half of hypopygium.
*minor* subsp. *tayabasensis* subsp. nov.

8. Last abdominal tergite with the area distad of the median tubercle distinctly transversely concave, the thin apical margin of the tergite strongly reflexed.................................. *minor* subsp. *islandica* subsp. nov.

Last abdominal tergite with the area distad of the median tubercle practically flat, the thin apical margin of the tergite scarcely reflexed.. 9.

9. Space between the ocelli and the eyes closely, distinctly punctate; pronotum with comparatively thick, appressed, pale pubescence in addition to the sparse, erect, pale pubescence........................................ 10.

Space between the ocelli and the eyes sparsely shallowly punctate; pronotum without appressed, pale pubescence, or with very sparse, appressed, pale pubescence in addition to the sparse, erect, pale pubescence ........................................ *minor* subsp. *visayensis* subsp. nov.

10. Second tergite clothed with very sparse, pale pubescence, the thin apical fringe entirely pale .............................. *minor* subsp. *minor* (Ashmead).

At least the thin apical fringe, excluding the lateral sixths, dark, almost black, and the median two-thirds of the posterior fourth of the second tergite with more or less dark to black, very sparse pubescence. Cape Engaño .............................. *minor* subsp. *whiteheadi* subsp. nov.

11. First and second segments of flagellum subequal in length; median area of clypeus with a low, median, longitudinal, inconspicuous ridge 12.

First segment of flagellum distinctly longer than the second; median area of clypeus prominently elevated along the median line into a blunt ridge, terminating anteriorly in a prominent, submarginal, blunt tubercle ........................................ 13.

12. At least the second and third abdominal segments ferruginous.
*eremita* subsp. *eremita* sp. et subsp. nov.

At least the third abdominal segment black, and usually the second broadly along the longitudinal midline, thus the second tergite with a pair of large, lateral, ferruginous spots.
*eremita* subsp. *umbra* subsp. nov.

13. Median carina of first sternite conspicuously elevated posteriorly, the elevation broadened, strongly, transversely compressed and with the apex squarely truncate; posterior fourth of last tergite (area caudad of glabrous, tumescent area) elevated along the longitudinal midline, sloping to the sides, and with close, small punctures........................ 14.

Median carina of first sternite only slightly elevated posteriorly, the apex of the elevation not broadened, nor flattened, nor truncate; posterior fourth of last tergite (area caudad of glabrous, tumescent area) not sloping to the sides from an elevated longitudinal midline................ 15.

14. Only the second and third abdominal segments, or segments one to three, ferruginous ................ *luzonica* subsp. *luzonica* (Radoskowski).
Second, third, and fourth abdominal segments, or segments one to four, ferruginous ........................ *luzonica* subsp. *panayensis* subsp. nov.

15. Posterior third of last tergite separated from the anterior two-thirds by a distinct, transverse depression extending the full width of the tergite; glabrous, tumescent area distinctly triangular in shape. *depressula* sp. nov.
Posterior third of last tergite not separated from the anterior two-thirds by a depression, slightly concave and with small, sparse punctures; glabrous, tumescent area elongate, subrectangular, the sides only slightly diverging ........................................................... *bakeri* sp. nov.

16. Tegulæ glabrous, impunctate; first five abdominal segments ferruginous; abdominal tergites without transverse, pale pubescent bands. *tethys* sp. nov.
Tegulæ finely, closely punctate and pubescent throughout; only first three or, sometimes, first four abdominal segments ferruginous; fifth abdominal tergite with a broad, apical, band of dense, pale pubescence. *tegularia* sp. nov.

17. At least the first segment of the flagellum beneath, and often the proximal half of the second segment beneath, distinctly yellow................ 21.
Flagellum entirely black throughout........................................................ 18.

18. First segment of flagellum equal in length to the second; tegulæ microreticulate, subopaque, feebly rugose near the outer and posterior margins .................................................... *ira* subsp. *palawana* subsp. nov.
First segment of flagellum slightly but distinctly shorter than the second; tegulæ glabrous, more or less punctate and pubescent........ 19.

19. Abdomen more or less ferruginous............................................................ 20.
Head, thorax, and abdomen entirely black..................... *nigerrima* sp. nov.

20. Tegulæ punctate and pubescent throughout; only abdominal segments one and two ferruginous; second tergite with moderate, deep, well-separated punctures; pronotum and mesonotum with moderate, close, more or less confluent punctures................................ *temeraria* sp. nov.
Outer posterior fourth of tegulæ mostly impunctate; abdominal segments one to three ferruginous; second tergite with fine, very sparse punctures; pronotum and mesonotum with moderate to small, well-separated to sparse punctures........................................ *fortuita* sp. nov.

21. At least the second abdominal segment, in whole or in part, ferruginous ............................ *sticticornis* subsp. *sticticornis* sp. et subsp. nov.
Head, thorax and abdomen entirely black. *sticticornis* subsp. *nigridia* subsp. nov.

### FEMALES

1. Pygidium longitudinally striated.............................................................. 5.
Pygidium sculptured otherwise ................................................................... 2.

2. Pygidial area glabrous, unsculptured; at least the coxæ, trochanters and femora except the tips, ferruginous............................................ 11.
Pygidial area not glabrous, roughly sculptured; legs entirely black.... 3.

3. Pygidial area irregularly rugose throughout; longitudinal carina of first sternite entire, not emarginate .......... 4.

Basal half of pygidial area irregularly rugose, the apical half granulated; longitudinal carina of first sternite emarginate, thus interrupted .......... *manilensis* (Brown).

4. Fourth tergite entirely black pubescent.
*philippinensis* subsp. *philippinensis* (Smith).

Fourth tergite with a pair of lateral spots of pale pubescence.
*philippinensis* subsp. *williamsi* subsp. nov.

5. Pale pubescent spots of second tergite subcircular in form, only very slightly longer than broad .......... 6.

Pale pubescent spots of second tergite strongly elongate-ovate in form, about twice as long as broad .......... 10.

6. Antennal tubercles distinctly ferruginous; pale pubescent band of third tergite entire, not at all emarginate nor interrupted medially .......... 7.

Antennal tubercles entirely black; pale pubescent band of third tergite either distinctly interrupted medially, or with an anterior median emargination, seldom entire .......... 9.

7. Apical margin of second tergite with a thin, apical fringe of pale pubescence; pygidial striæ reaching or almost reaching the posterior margin of pygidium .......... *minor* susbp. *minor* (Ashmead).

Apical margin of second tergite entirely black pubescent, except the lateral extremes; pygidial striæ usually not extending onto the posterior third of pygidium .......... 8.

8. Tayabas area (see introduction) .... *minor* subsp. *tayabasensis* subsp. nov.
Visayas area .......... *minor* subsp. *visayensis* subsp. nov.
Mindanao area .......... *minor* subsp. *islandica* subsp. nov.

9. Pale pubescent band of third tergite with a more or less well-developed anterior, median, triangular emargination.
*eremita* subsp. *eremita* sp. et subsp. nov.

Pale pubescent band of third tergite distinctly interrupted medially with black .......... *eremita* subsp. *umbra* subsp. nov.

10. Pubescent markings of abdomen pale silvery; distance between pubescent spots of second tergite one and one-half times their transverse diameter; pygidium striate only on basal half.
*ovatula* subsp. *ovatula* sp. et subsp. nov.

Pubescent markings of abdomen distinctly golden; distance between pubescent spots of second tergite about equal to their transverse diameter; pygidial striæ extending almost to posterior margin.
*ovatula* subsp. *aurifera* subsp. nov.

11. Second tergite with a pair of anterior, subcircular, pale pubescent spots .......... 12.

Second tergite with a pair of parallel lines of pale pubescence on the anterior half, the lines extending to the anterior margin.
*proserpina* subsp. *sibuyanensis* subsp. nov.

12. Apex of femora, and tibiæ entirely black, much darker in color than the ferruginous femora .......... *proserpina* subsp. *tibiata* subsp. nov.

Apex of femora, and tibiæ, ferruginous, practically concolorous with the femora .......... *proserpina* subsp. *proserpina* (Smith).

**TIMULLA (TROGASPIDIA) PHILIPPINENSIS subsp. PHILIPPINENSIS (Smith).**

1855. *Mutilla philippinensis* SMITH, Cat. Hymen. Brit. Mus. 3: 40, female.
1869. *Mutilla accedens* SICHEL and RADOSKOWSKI, Horae soc. ent. Rossicae 6: 227–228, female.
1869. *Mutilla dimidiata* SICHEL and RADOSKOWSKI, Horae soc. ent. Rossicae 6: 285–286, male (in part; Luzon specimens).
1895. *Mutilla suspiciosa* BINGHAM, Ann. & Mag. Nat. Hist. VI 16: 440–441, female and male (in part) (nec Smith).
1897. *Mutilla philippinensis* DALLE TORRE, Cat. Hymen. 8: 73, female.
1903. *Mutilla philippinensis* ANDRÉ, Gen. Ins. 1, fasc. 11: 40, female.
1904. *Mutilla philippinensis* ASHMEAD, Proc. U. S. Nat. Mus. 28: 152, female.
1905. *Trogaspidia bicolor* ASHMEAD, Proc. U. S. Nat. Mus. 28: 962, male.
1906. *Mutilla accedens* BROWN, Philip. Journ. Sci. 1: 689, female.
1906. *Mutilla philippinensis* BROWN, Philip. Journ. Sci. 1: 689, female.
1906. *Mutilla suspiciosa* BROWN, Philip. Journ. Sci. 1: 689, male and female.
1906. *Trogaspidia bicolor* BROWN, Philip. Journ. Sci. 1: 689, male.
1906. *Mutilla dimidiata* BROWN, Philip. Journ. Sci. 1: 689, male.
1913. *Mutilla ianthea* ZAVATTARI, Boll. soc. ent. Ital. 45: 75, female (in part) (Manila specimen).
1927. *Trogaspidia bicolor* COCKERELL, Philip. Journ. Sci. 33: 277, male.
1927. *Trogaspidia dimidiata* COCKERELL, Philip. Journ. Sci. 33: 277, male.

*Holotype.*—Female, Philippine Islands, in British Museum of Natural History.

*Specimens examined.*—LUZON, male, Los Baños, June, 1916 (*F. X. Williams*); male, Los Baños, June–July, 1917 (*F. X. Williams*); female, 2 males, Los Baños, July, 1916 (*F. X. Williams*); 3 females, male, Los Baños, July–August, 1917 (*F. X. Williams*); 3 females, 21 males, Los Baños, August, 1916 (*F. X. Williams*); female, male, Los Baños, September, 1916 (*F. X. Williams*); female, male, Los Baños, 1917 (*F. X. Williams*); 6 females, 5 males, 1 pair in coitu, Los Baños, 1917 (*F. X. Williams*); 3 females, 8 males, Los Baños (*Baker*); 2 females, 11 males, Mount Maquiling (*Baker*); male, Manila; 2 males, Lamao, March–June, 1911 (*C. V. Piper*); 2 females, 2 males, Mount Banahao (*Baker*); female, Mount Banahao (*W. Schultze*); male Montalban, Rizal, 1913 (*G. Villegas*); female, Nueva Ecija Province (*W. Schultze*); female, Olongapo, Zambales Province, June 8, 1907 (*C. S. Banks*); female, Baguio, Benguet Subprovince, March 3 (*C. S. Banks*); female, Balali, Benguet (*A. Shick*); male, Irisan, May 21, 1903 (*R. C. McGregor*); male, Peña

Blanca, Cagayan, October, 1922 (*R. C. McGregor*); female, Sanchez Mira, Cagayan (*C. R. Jones*); female, three males, Cape Engaño (*Whitehead*); male, Limay; male, Imugan; female, Isabela; male, Buraner; female, male (*C. R. Jones*). POLILLO, 2 females (*Taylor*). CEBU, 2 females, April, 1917 (*F. X. Williams*). NEGROS, male, Cuernos Mountains (*Baker*); male, Maao, July 25, 1902 (*C. S. Banks*); male, Maao, July 30, 1902 (*C. S. Banks*); female, Dumoguere, April, 1917 (*F. X. Williams*). PANAY, female, Culasi, June 6, 1918 (*R. C. McGregor*); female, Culasi, June (*R. C. McGregor*). MINDANAO, female, 5 males, Dapitan (*Baker*); female, Cagayan (*Baker*). PALAWAN, 3 males, Puerta Princesa (*Baker*).

The male of this species is readily distinguished from other Philippine species by its large size and the absence of a distinct excision on the mandibles beneath near the base. The male specimens examined vary in length from 18 to 25 millimeters. The females are distinctive on account of the pygidium being irregularly rugose throughout and their large size. The female specimens vary in length from 12 to 18 millimeters. The two sexes have been correlated on evidence from pairs taken in coitu; one pair at Cape Engaño, reported by Bingham, and a pair in the material collected at Los Baños by Dr. F. X. Williams, as noted above. I have examined Smith's type of *philippinensis* and Ashmead's type of *bicolor;* the specimens listed above agree specifically with the two types; *bicolor*, being the most recent name, falls as a synonym.

I have been unable to locate any specimen that satisfies the requirements for a type of *accedens* Sichel and Radoskowski. A specimen determined by Radoskowski as *accedens* is in the Zoologisches Museum der Universität, Berlin. It agrees with the original description, but the locality label reads "Jalajala," while the description cites the type locality as Manila. This specimen is identical with Smith's type of *philippinensis*. A second specimen is in the Musée Physiographique de l'Academie Polonaise des Sciences Cracovie which was also determined by Radoskowski as *accedens*. This specimen has no locality label. It is a specimen of the subspecies *williamsi* described hereafter. This subspecies has a pair of lateral, pale pubescent spots on the fourth tergite, of which no mention is made in the original description of *accedens*. On the basis of the characters cited in the original description and the specimens determined by Radoskowski, which have been examined, there can be no doubt that *accedens* should fall as a synonym of *philippinensis* Smith.

The Luzon specimen of *dimidiata* mentioned by Sichel and Radoskowski can be definitely placed as a male specimen of this species from the description of the color of the abdomen and the large size. The specimens assigned by them to the species *philippinensis* were incorrectly determined and are the same as a new species described hereafter.

I have also examined the specimens from Cape Engaño which were determined by Bingham as *suspiciosa* Smith. This series consists of several species a part of which are specimens, both male and female, of *philippinensis*.

I have not seen the specimen from Manila determined by Zavattari as *ianthea*, but judging by the characters Zavattari used in keying out *ianthea* in his paper I think it probable that he had a specimen of this species.

This species is very uniform in sculpture and coloration throughout its range in the Philippine Islands. I have examined the specimens carefully, including the genitalia of the males, for subspecific differences in specimens from the various islands but have found no indication of any subspecific variation.

### TIMULLA (TROGASPIDIA) PHILIPPINENSIS subsp. WILLIAMSI subsp. nov.

*Female.*—Head, abdomen, and legs black; thorax entirely ferruginous; second abdominal tergite with a pair of large, elongate, ovate spots of pale pubescence on the anterior half, the spots not extending to the anterior margin of the tergite; fourth tergite with a pair of lateral, subquadrate, somewhat obscure, pale pubescent spots, the latter not extending to the lateral margins of the tergite; fifth tergite entirely black pubescent; pygidial tergite, except the pygidial area, clothed with thick, erect, pale pubescence; pygidial area irregularly rugose throughout; apical margins of second and third sternites with thick, appressed, pale pubescence; the apical margins of the fourth and fifth sternites, each with a thin fringe of pale fuscous pubescence. Length, 13 millimeters.

*Holotype.*—LUZON, female, Los Baños, March, 1917 (*F. X. Williams*), in collection of University of Minnesota.

*Paratype.*—LUZON, female, Los Baños.

This subspecies is exactly like typical *philippinensis* females, except for the pale spots on the fourth tergite and its smaller size. The specimen without locality label determined by Radoskowski as *accedens*, mentioned above as being in the Musée Physiographique at Krakow, Poland, is an example of this subspecies. The paratype differs from the holotype in having obscure pale spots on the fifth tergite as well as on the fourth and is still smaller, being only 10 millimeters in length. It appears to be an abnormally colored specimen in other respects than the pale maculations.

**TIMULLA (TROGASPIDIA) PHILIPPINENSIS subsp. ITAMBUSA (Cockerell).**

1927. *Trogaspidia itambusa* COCKERELL, Philip. Journ. Sci. **33**: 275–277, male.

*Holotype.*—LUZON, male, Lucban, Tayabas Province, May, 1926 (*McGregor*), in the United States National Museum.

I have seen only the unique type of this subspecies. It is exactly like the males of *philippinensis*, except that the body is entirely black.

**TIMULLA (TROGASPIDIA) MINOR subsp. MINOR (Ashmead). Plate 1, fig. 3.**

1869. *Mutilla vicina* SICHEL and RADOSKOWSKI, Horae soc. ent. Rossicae **6**: 228, female (in part; Luzon specimen).
1869. *Mutilla analis* SICHEL and RADOSKOWSKI, Horae soc. ent. Rossicae **6**: 284–285, male (in part; Luzon specimen).
1905. *Trogaspidia minor* ASHMEAD, Proc. U. S. Nat. Mus. **28**: 963, male.
1906. *Mutilla analis* BROWN, Philip. Journ. Sci. **1**: 689, male.
1906. *Trogaspidia minor* BROWN, Philip. Journ. Sci. **1**: 689, male.
1910. *Mutilla browni* ROHWER, Proc. U. S. Nat. Mus. **37**: 658, female.
1919. *Mutilla* sp. WILLIAMS, Bull. Ent. Ser., Hawaiian Sugar Planter's Exp. Station **14**: 63, female.

*Holotype.*—LUZON, male, Manila, in United States National Museum.

*Specimens examined.*—LUZON, female, male, Los Baños, March, 1917 (*F. X. Williams*); 4 males, Los Baños, March–June, 1925 (*Pemberton*); male, Los Baños, Laguna, March, 1910 (*E. M. Ledyard*); female, male, Los Baños, June–July, 1917 (*F. X. Williams*); 2 females, 3 males, Los Baños, July, 1916 (*F. X. Williams*); 6 females, 2 males, Los Baños, July–August, 1917 (*F. X. Williams*); 7 females, 2 males, Los Baños, August, 1916 (*F. X. Williams*); male, Los Baños, August, 1917 (*F. X. Williams*); male, Los Baños, September, 1916 (*F. X. Williams*); female, Los Baños, September, 1917 (*F. X. Williams*); 2 females, male, and 2 pairs in coitu, Los Baños, 1916 (*F. X. Williams*); 14 females, 37 males, and 3 pairs in coitu, Los Baños, 1917 (*F. X. Williams*); female, Los Baños (*F. X. Williams*); 17 females, 39 males, Los Baños (*Baker*); male, Los Baños (*G. Villegas*); 5 females, 30 males, Mount Maquiling (*Baker*); 2 females, 2 males, Mount Banahao (*Baker*); male, Manila, August, 1923

(*R. C. McGregor*); male, Manila, February, 1919 (*R. C. McGregor*); male, Manila; female, Montalban Gorge, Rizal, March, 1906 (*C. S. Banks*); female, Imugan, Nueva Vizcaya Province (*Baker*); female, male, Baguio, Benguet (*Baker*); male, Fort William McKinley, Rizal Province, September 7, 1920; male, Lamao, Bataan Province, September, 1912 (*W. Schultze*); two males (*C. S. Banks*); female, male (*C. R. Jones*).

This and the five subspecies that follow are very closely related subspecies of *minor* Ashmead. These six subspecies are restricted to definite geographic areas in the Philippines. The species *minor* appears to be one which has recently given rise, or is in the process of giving rise, to subspecies and ultimately species. It appears to be due, in part at least, to the factor of geographic isolation. It has been possible to construct a key for the separation of the six subspecies of males based on external characters, but this key is far from infallible and must be used in connection with the structures of the male genitalia and our knowledge of the geographic distribution of the various subspecies. The genitalia of the males exhibit distinct differences which appear to be constant in each subspecies. The separation of the males of the various subspecies is therefore based primarily on the variations in the form of the uncus of the genitalia of the males. The geographic distribution of each subspecies is based on information from specimens identified by means of the genitalia. The females, with the exception of the type subspecies, are inseparable except on the basis of geographic distribution and their association with the males. After hours of minute and critical examination of numerous specimens of females no character has been found that will serve to differentiate the females of the various subspecies, with the exception that the characters cited in the key will separate the subspecies *minor* from the others.

The subspecies *minor* has been reared from the cocoons of *Tiphia lucida* Ashmead by Dr. F. X. Williams (1919). Although I have not seen the specimens actually reared by Williams, there can be no question, after a study of his published figure and the locality where the females were collected, that this is the species and subspecies which he had.

It will be noted above that five males and five females have been taken in coitu so that the association of the two sexes has been substantiated several times over. I have examined Ashmead's holotype and find it to be the same as the subspecies *minor*. Rohwer's holotype of *browni* has also been examined and the females placed here are identical with it. Since the name *minor* has priority *browni* must fall as a synonym. The specimen from Luzon recorded by Sichel and Radoskowski as *analis* Lepeletier has also been examined and found to be identical with this species. The specimen of *vicina* from Luzon mentioned by the same authors is in the Krakow Museum, and upon examination proved to be the same as the females placed here.

The collections studied indicate that *minor* subsp. *minor* is the commonest mutillid in the vicinity of Manila and Los Baños.

The figures that illustrate this species were made from mounted genitalia of a specimen in the collection of the University of Minnesota, slide No. 5, mutillid genitalia.

**TIMULLA (TROGASPIDIA) MINOR subsp. WHITEHEADI subsp. nov. Plate 1, fig. 4.**

1895. *Mutilla suspiciosa* BINGHAM, Ann. & Mag. Nat. Hist. VI **16**: 440–441, male (in part) (nec Smith).

*Male*.—Head, thorax, posterior half of fifth abdominal tergite, sixth and seventh abdominal segments entirely, and legs, black; abdominal segments one to four, and anterior half of fifth, ferruginous; exactly like *minor* subsp. *minor* except the posterior third of the second tergite medially with sparse, dark fuscous pubescence, the lateral fourths of the same tergite with pale pubescence throughout; the thin, apical fringe of second tergite, except lateral sixths, also dark fuscous. Length, 14 millimeters.

*Holotype*.—LUZON, male, Cape Engaño (*Whitehead*), in British Museum of Natural History. Genitalia of type specimen mounted on slide No. 12.

*Paratype*.—LUZON, male, Cape Engaño (*Whitehead*).

Two of the male specimens determined by Bingham as *suspiciosa* belong here. Externally these specimens are exceedingly like the subsp. *minor*, but the second tergite is in part clothed with dark fuscous pubescence as described above. The uncus of the genitalia is very different from that of subsp. *minor* as will be seen from the figure. Apparently *whiteheadi* is very restricted in distribution as a specimen from Mountain Province, Baguio, Benguet, is typical subsp. *minor* both externally and with reference to the uncus of the genitalia.

**TIMULLA (TROGASPIDIA) MINOR subsp. TAYABASENSIS subsp. nov. Plate 1, fig. 5.**

*Male*.—Head, thorax, legs, and first, fourth, fifth, sixth, and last abdominal segments black; second and third abdominal segments ferruginous; exactly like subsp. *minor* except the first abdominal segment almost entirely black, the posterior fourth slightly suffused with ferruginous. Length, 13 millimeters.

*Female.*—Head, abdomen, and legs black; thorax ferruginous; antennal tubercles ferruginous; differs from subsp. *minor* in having the apical fringe of the second abdominal tergite, except lateral eighths, entirely black, and the striæ of the pygidium present only on the anterior three-fourths, the posterior fourth of pygidium faintly granulate. It agrees in both these characters with the following subspecies and is inseparable morphologically from them. Length, 8 millimeters.

*Holotype.*—Male, catalogue No. 49332, United States National Museum, POLILLO (*Baker*), taken in coitu with allotype female.

*Allotype.*—POLILLO, female (*Baker*), taken in coitu with holotype male.

*Paratypes.*—POLILLO, male (*Baker*); female (*R. C. McGregor*). LUZON, male, Malinao, Tayabas Province (*Baker*); female (*S. Jagor*).

The males of *tayabasensis* are easily separated from all the other subspecies by the almost entirely black first abdominal segment, and by the form of the uncus and squamæ of the genitalia. The specimen from Malinao has been carefully compared with the holotype and found to be identical in all respects. The figures of the male genitalia are drawn from the Malinao specimen, slide No. 13. The females are readily distinguishable from the subsp. *minor* as mentioned above, but although an exhaustive search has been made to find some means of separating *tayabasensis* females from the following subspecies, no serviceable characters have been found.

### TIMULLA (TROGASPIDIA) MINOR subsp. VISAYENSIS subsp. nov. Plate 1, fig. 6.

1931. *Trogaspidia minor* LOPEZ, Ann. Rept. Research Dept., Philip. Sugar Assoc. for 1930–31, pp. 246–247, pl. 7, fig. 3, male.

1931. *Trogaspidia browni* LOPEZ, Ann. Rept. Research Dept., Philip. Sugar Assoc. for 1930–31, p. 247, female.

*Male.*—Head, thorax, legs, posterior half of fifth abdominal segment, sixth and last abdominal segments, all black; first four abdominal segments, and anterior half of fifth, all ferruginous; space between ocelli and eyes sparsely punctate; pronotum clothed for the most part with sparse, erect, pale pubescence, the sparse, appressed, pale pubescence obscure. Length, 16 millimeters.

*Female.*—Head, abdomen, and legs black; thorax ferruginous; antennal tubercles ferruginous; pygidium longitudinally striate, the striæ not extending to the apical margin, the posterior fourth of pygidium faintly granulate. Indistinguishable from subsp. *tayabasensis*. Length, 10 millimeters.

*Holotype.*—Male, catalogue No. 49333, United States National Museum, PANAY, northwestern part (*Baker*), taken in coitu with allotype female.

*Allotype.*—PANAY, female, northwestern part (*Baker*), taken in coitu with allotype male.

*Paratypes.*—PANAY, female, Culasi, Antique Province, May 1, 1918 (*R. C. McGregor*); male, Culasi, May 11, 1918 (*R. C. McGregor*); female, Culasi, May 16, 1918 (*R. C. McGregor*); female, Culasi, June 6, 1918 (*R. C. McGregor*); 2 females, 2 males, Culasi, June (*R. C. McGregor*); 6 males, Culasi, July 6, 1918 (*R. C. McGregor*); 4 males, Culasi (*R. C. McGregor*); 4 females, 10 males, northwestern part (*Baker*). BATBATAN, male, June, 1918 (*R. C. McGregor*). SIBUYAN, 20 females, 13 males (*Baker*); 2 females, June, 1904 (*R. C. McGregor*). NEGROS, female and male in coitu, Cadiz, August 28, 1929; female, Cadiz, July 3, 1929; female and male, Victorias, February 13, 1930; male, Victorias, July 10, 1928; female, Victorias, August 24, 1930; female, Victorias, August 28, 1930; female, Victorias, November 16, 1928; male, La Carlota Central, March 10, 1931; male, La Carlota Central, April 18, 1931; female, La Carlota Central, July 30, 1931; 5 males, Hawaiian-Philippine Central, June 20, 1930; male, Hawaiian-Philippine Central, August 25, 1929; 2 males, Binalbagan, May 28, 1931; male, Maao, July 27, 1902 (*C. S. Banks*); 2 males, Maao, July, 1902 (*C. S. Banks*); male, Bago, June, 1906; female, 5 males, Cuernos Mountains (*Baker*); 2 males. CEBU, 5 females, April, 1917 (*F. X. Williams*).

The male of this subspecies may be separated from related subspecies by the characters mentioned above. The male genitalia are very different from the related forms (see figure). The genitalia of male specimens from Panay, Batbatan, Sibuyan, and Negros have been examined and all found to be the same. I have had the opportunity of examining the specimens mentioned by Lopez (1931) and find them identical with this subspecies. The females are indistinguishable from the subspecies *tayabasensis* and *islandica*. It will be noted that a second pair taken in coitu is mentioned above from Cadiz, Occidental Negros. The figures of the uncus and squamæ of the male genitalia were drawn from a specimen collected in northwestern Panay (*Baker*) and are mounted on slide No. 7.

### TIMULLA (TROGASPIDIA) MINOR subsp. ISLANDICA subsp. nov. Plate 1, fig. 7.

*Male.*—Head, thorax, last three abdominal segments, and legs black; abdominal segments one to four entirely ferruginous; front, pronotum, dorsum of propodeum, and elevated area of mesopleuræ with dense, appressed, pale pubescence; thin apical margin of last tergite strongly reflexed, thus the area distad of the pygidial tubercle distinctly, transversely concave. Length, 15 millimeters.

*Female.*—Head, abdomen, and legs black; thorax ferruginous; antennal tubercles ferruginous; pygidium longitudinally striate, the striæ not extending to the apical margin, the posterior fifth of pygidium faintly granulate. Indistinguishable from the subspecies *tayabasensis* and *visayensis*. Length, 9 millimeters.

*Holotype.*—Male, catalogue No. 49334, United States National Museum, MINDANAO, Surigao (*Baker*).

*Allotype.*—MINDANAO, female, Surigao (*Baker*).

*Paratypes.*—LUZON, male, Damalon. SAMAR, female, male, Catbalogan; female, May 23, 1924 (*R. C. McGregor*); female, June 4, 1924 (*R. C. McGregor*); male, June 14, 1924 (*R. C. McGregor*); male, June 24, 1924 (*R. C. McGregor*); 4 females, 11 males (*Baker*). BILIRAN, female, 4 males (*Baker*). BOHOL, male. MINDANAO, 40 females, 88 males (*Baker*); 3 females, 7 males, Butuan (*Baker*); male, Butuan; male, Camiguin; female, 2 males, Cagayan (*Baker*); 5 males, Tangkulan (*Baker*); female, 2 males, Iligan (*Baker*); 5 females, 2 males, Kolambugan (*Baker*); male, Kolambugan, 1914 (*C. S. Banks*); 22 females, 55 males, Dapitan (*Baker*); female, Mati, Davao, March, 1927 (*E. A. McGregor*); 10 females, 41 males, Davao (*Baker*); female, 6 males, Zamboanga (*Baker*); female, Malangas, 1919 (*C. S. Banks*). BASILAN, female, 6 males (*Baker*).

The dense, appressed pubescence of the pronotum, the transversely concave area on the posterior portion of the last tergite, and the characteristic male genitalia serve to distinguish the male of this subspecies. The males vary in the number of ferruginous abdominal segments; about 60 per cent of the males have abdominal segments one to four only, ferruginous, while 40 per cent have segments one to five ferruginous. The sexes have not been taken in coitu, but since the females are indistinguishable from the subspecies *tayabasensis* and *visayensis*, the specimens placed here are assigned to these males on the basis of geographic distribution.

### TIMULLA (TROGASPIDIA) MINOR subsp. PRINCESA subsp. nov. Plate 1, fig. 8.

*Male.*—Head, thorax, first and last two abdominal segments, and legs black; abdominal segments two to five ferruginous; pronotum clothed only with sparse, erect, inconspicuous, pale pubescence; first abdominal tergite tinged with ferruginous at the posterior margin; hypopygial ridges extending on to the posterior half of the hypopygium. Length, 15 millimeters.

*Holotype.*—Male, catalogue No. 49335, United States National Museum, PALAWAN, Puerta Princesa (*Baker*).

*Paratype.*—PALAWAN, male, Puerta Princesa (*Baker*).

The subspecies *princesa* and *tayabasensis* differ from the other subspecies of *minor* in having the first abdominal segment largely black; *princesa* also differs from *islandica* in having the pronotum with only sparse, erect, pale pubescence. It differs from *tayabasensis* in having abdominal segments two to five ferruginous, instead of two to four, and in the longer hypopygial ridges. The uncus and squamæ of the genitalia differ as indicated in the figure. Genitalia are mounted on slide No. 11.

### TIMULLA (TROGASPIDIA) EREMITA subsp. EREMITA sp. et subsp. nov.

*Male.*—Head, thorax, last four abdominal segments, and legs black; first three abdominal segments ferruginous; mandibles deeply excised beneath near the base; median area of clypeus slightly concave, with a median, weak, longitudinal ridge; first segment of flagellum subequal in length to the second; last tergite with a median, elongate, tumescent area, rounded off apically and not terminating in a tubercle; lateral areas of pygidial tergite with thick, erect, black pubescence. Length, 18 millimeters.

Head entirely black, the front, vertex, and genæ clothed with sparse, erect, black pubescence, the front and genæ also with sparse, appressed, pale pubescence; mandibles deeply excised beneath forming a strong tooth beneath near the base; lateral areas and posterior margin of clypeus pale pubescent; median area of clypeus large, pentagonal in outline, slightly concave, with a weak, median, longitudinal ridge, and entirely glabrous, impunctate, except a submarginal, transverse row of close punctures and erect, pale hairs at the anterior margin; scape distinctly bicarinate beneath, clothed with sparse, pale pubescence; first segment of flagellum subequal in length to the second;

antennal scrobes distinctly carinate above; front with large, close, confluent punctures, becoming shallow, obsolete anteriorly between the antennal tubercles; space between the ocelli and the eyes sparsely punctate; vertex with large, shallow, separated punctures, the genæ with moderate, shallow, separated punctures; ocelli small, the distance between the lateral ocelli and the eye margins five to six times the diameter of a lateral ocellus; relative widths of head and thorax including the tegulæ, 6.0: 8.5.

Thorax entirely black; pronotum, mesonotum, and scutellum clothed with sparse, erect, black pubescence; dorsum and posterior face of propodeum with sparse, erect, pale pubescence, the dorsum also with sparse, appressed, pale pubescence; propleuræ clothed with sparse, erect, pale pubescence; mesopleuræ with sparse, pale pubescence, that on the elevated areas thicker and appressed; metapleuræ and sides of propodeum with pale micropubescence; pronotum and mesonotum with large, deep, confluent punctures; parapsidal furrows deep and distinct on the posterior two-thirds of mesonotum; scutellum with large, dense, deep, confluent punctures, strongly elevated, the anterior half with a median, longitudinal, broad, glabrous, furrowed line, terminating at the apex of the elevation; dorsum and posterior face of propodeum rounded into one another, distinctly reticulate, somewhat more broadly so on the dorsum than on the posterior face; lateral margins of dorsum of propodeum defined by a raised, glabrous line; dorsum of propodeum with an elongate, triangular, inclosed area, the latter two and one-half times as long as broad at the base and elevated into a slight tubercle posteriorly; propleuræ rugose-punctate; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by a deep furrow, and with large, dense, confluent punctures, the latter shallow and obsolete at the anterior and posterior margins of mesopleuræ; metapleuræ micropunctate, glabrous, with large, shallow punctures ventrally; sides of propodeum micropunctate at the anterior margin, shallowly reticulate on the posterior three-fourths; tegulæ large, glabrous, impunctate, except the anterior and inner margins punctate and black pubescent.

Abdomen black, except the first three abdominal segments ferruginous; first tergite with large, shallow, separated punctures becoming smaller and closer at the posterior margin and clothed with sparse, erect, pale golden pubescence; second tergite almost impunctate and bare medially, the lateral areas with moderate, sparse punctures, and very sparse, erect, pale golden pubescence; tergites three to six with sparse, moderate punctures, the third with sparse, erect, pale golden pubescence, the fourth, fifth, and sixth with sparse, erect, black pubescence; last tergite with a median, longitudinal, glabrous, tumescent area rounded off posteriorly, not terminating in a tubercle, the lateral areas of the tergite with very thick, erect, black pubescence; first sternite with a median, longitudinal carina on the anterior two-thirds, the carina somewhat elevated posteriorly; second sternite with moderately large, distinct, well-separated punctures becoming smaller at the posterior margin, clothed with very sparse, pale golden pubescence; sternites three to six with moderate, close punctures posteriorly, the third with sparse, pale golden pubescence, the fourth with similar fuscous pubescence, the fifth and sixth with black pubescence; seventh sternite with a pair of small, obscure tubercles at the posterolateral angles; hypopygium with a pair of lateral, elevated, glabrous ridges on the anterior half and extending slightly on to the posterior half, slightly converging posteriorly, the interspace with moderately small, close punctures and sparse, erect, black pubescence.

Wings fuliginous with violet reflections; cell 2d $R_1 + R_2$ broadly truncate at the apex, slightly longer than cell R + 1st $R_1$; cell $R_5$ receiving vein $M_{3+4}$ at five-eighths the distance from base to apex; cell $R_4$ present but less distinct than $R_5$ and receiving vein $M_2$ at three-fifths the distance from base to apex.

Legs entirely black, clothed with sparse, pale pubescence; calcaria pale.

*Female.*—Head, abdomen, and legs black, the thorax entirely ferruginous; second tergite with a pair of elongate, ovate spots of dense, appressed, pale pubescence on the anterior half; third tergite with a broad band of dense, appressed, pale pubescence, distinctly, triangularly emarginate anteriorly at the middle; pygidium longitudinally striate, the striæ not extending to the posterior margin. Length, 12 millimeters.

Head entirely black including the antennal tubercles, and excepting the flagellum beneath beyond segment two tinged with ferruginous; front and vertex with sparse, erect, black pubescence, except the anterior margin of the front with scattered, pale hairs; genæ with sparse, appressed, pale pubescence; mandibles slender, edentate at the apex and with a very small tooth within near the apex; clypeus elevated posteriorly, the elevated posterior margin slightly arcuate, and with a small tubercle just posterior to the arcuate margin medially; antennal tubercles approximate; scape with shallow, indistinct punctures and sparse, pale pubescence; first segment of flagellum almost twice as long as the second; antennal scrobes distinctly carinate above; front and vertex moderately, longitudinally rugose-punctate; genæ with moderate, close, somewhat confluent punctures; relative widths of head and thorax, 4.9: 4.7.

Thorax entirely ferruginous, the dorsum clothed with long, erect, and short, semierect, fuscous pubescence; humeral angles somewhat rounded, not sharply angulate; lateral margins of pronotal area with a small tubercle just behind the middle; mesonotal area slightly narrower than the pronotum and propodeum, the lateral margins crenulate and slightly converging posteriorly; dorsum of thorax coarsely, densely, longitudinally rugose-punctate; scutellar scale broad and distinct; dorsum of propodeum deeply, broadly reticulate and asperated, the asperations formed by the elevated angles of the reticulations, this sculpture extending on to the anterior half of the posterior face of propodeum; posterior half of propodeum with small, separated punctures; pleural areas and sides of propodeum closely micropunctate and with pale micropubescence, the sides of propodeum also with a few, scattered, moderate punctures.

Abdomen entirely black; first tergite with scattered, moderate punctures and scattered, erect, pale hairs except the posterior fourth with dense, appressed and sparse, erect, black pubescence; second tergite with dense, appressed and sparse, erect, black pubescence, except the anterior half with a pair of elongate-ovate spots of dense, appressed, pale pubescence, the spots separated by a distance twice their transverse diameter, and the posterior two-thirds of the lateral margins with dense, appressed, pale pubescence; lateral areas of second tergite with the moderate, shallow, separated punctures distinct, elsewhere the punctures partially visible through the pubescence; third tergite with a broad band of dense, appressed, pale pubescence, deeply, triangulately emarginate anteriorly at the middle with black pubescence; fourth and fifth tergites clothed with thick, erect and recumbent, black pubescence; anterior margin of pygidial tergite with black pubescence, the areas adjoining the margin of the pygidium with pale pubescence; pygidium distinctly longitudinally striate, the striæ not extending to the posterior margin, the posterior fifth of the pygidium granulate; first sternite with a high, longitudinal carina on the anterior two-thirds, slightly elevated posteriorly; second sternite glabrous, with moderate, distinct, well-separated punctures; posterior margin of second and third sternites with a narrow band of dense, appressed, pale pubescence; sternites three to five with small, dense punctures at the posterior margin; apical fringe of fourth sternite intermixed with pale and black hairs, that of the fifth entirely black; hypopygium with small, close punctures and sparse, erect, pale pubescence.

Legs entirely black, clothed with pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49336, United States National Museum, MINDANAO, Tangkulan, Bukidnon Province (*Baker*).

*Allotype.*—MINDANAO, female, Tangkulan, Bukidnon Province (*Baker*).

*Paratypes.*—LUZON, 2 males, 12 females, Mount Maquiling (*Baker*); female, Mount Banahao (*Baker*); female, Los Baños (*G. Villegas*); male, Limay, Bataan Province; 3 females, Baguio, Benguet (*Baker*); female, Malinao, Tayabas (*Baker*). SAMAR, male, 4 females (*Baker*). BILIRAN, male (*Baker*). NEGROS, 2 females (*Baker*). PANAY, male, 2 females, northwestern part (*Baker*). MINDANAO, male, 8 females, Surigao (*Baker*); female, Surigao; 3 males, Tangkulan, Bukidnon (*Baker*); male, 4 females, Iligan (*Baker*); male, 2 females, Kolambugan (*Baker*); 5 males, 8 females, Dapitan (*Baker*); 4 females, Davao (*Baker*); female, Zamboanga (*Baker*); female, Mumungan. BASILAN, 2 females (*Baker*).

The two sexes united here have not been taken in coitu, but the evidence from geographic distribution regarding this and the following subspecies warrants this view. The geographic distribution of the females placed here coincides exactly with that of the males, except that in the latter where less material is available no specimens are at hand from LUZON, Baguio, Benguet; NEGROS; and MINDANAO, Davao.

The males vary in length from 13 to 21 millimeters; they also vary in the color of the first abdominal segment, some having the first segment black, others having it ferruginous; the male may be distinguished by the small number of ferruginous abdominal segments, by the form of the median area of the clypeus and by the brushlike pubescence on the lateral areas of the pygidial tergite. The females vary in length from 9 to 13 millimeters, and there is some variation in the depth of the emargination of the pubescent band on the third tergite; in some the emargination is very deep, in others very shallow. The female sex is easily confused with the subspecies of *minor;* it may be recognized by the black antennal tubercles and the emarginate pubescent band of the third tergite.

**TIMULLA (TROGASPIDIA) EREMITA subsp. UMBRA subsp. nov.**

1895. *Mutilla suspiciosa* BINGHAM, Ann. & Mag. Nat. Hist. VI 16: 440, female and male (in part) (nec Smith).

*Male.*—Exactly like typical *eremita* except the color of the abdomen; the latter entirely black except the second abdominal tergite with the lateral thirds, and the second sternite entirely, ferruginous. Length, 17 millimeters.

*Female.*—Exactly like typical *eremita* except the broad band a pale pubescence on the third abdominal tergite completely interrupted medially with black pubescence, the width of the interruption posteriorly equal to one-half the width of the pale pubescent band, the interruption slightly broader anteriorly. Length, 13.5 millimeters.

*Holotype.*—Male, catalogue No. 49337, United States National Museum, LUZON, Mount Banahao (*Baker*).

*Allotype.*—LUZON, female, Mount Banahao (*Baker*).

*Paratypes.*—LUZON, female, Los Baños, March–June, 1925 (*Pemberton*); female, Los Baños, September 10, 1920; female, Los Baños, 1917 (*F. X. Williams*); 6 females, 3 males, Mount Banahao (*Baker*); 7 females, 5 males, Mount Maquiling (*Baker*); 2 females, Balbalan; female, Malinao, Tayabas (*Baker*); female, Bangui, November, 1923; female, Lubuagan; female, Ripang; female, Imugan, Nueva Vizcaya (*Baker*); female, Baguio, Benguet (*Baker*); female, Calauan, Laguna Province, December 10, 1910 (*R. C. McGregor*); female, Isabela; female and male, Cape Engaño (*Whitehead*). POLILLO, female.

I have compared the males and females placed here critically with typical male and female *eremita* and find only the differences mentioned above. The genitalia of the two males are exactly the same. The males vary in length from 16 to 19 millimeters, and also vary considerably in the amount of black on the second abdominal tergite. The holotype and other specimens have the median third of the second tergite and a fairly broad posterior margin of the same tergite, black; while others have only the posterior margin dark; intergrades occur. In all specimens seen the first segment and the third tergite are black. The females vary in length from 8 to 13 millimeters. The male and female listed above from Cape Engaño were recorded by Bingham as *suspiciosa* Smith.

**TIMULLA (TROGASPIDIA) LUZONICA subsp. LUZONICA (Radoskowski). Plate 1, fig. 9.**

1885. *Mutilla luzonica* RADOSKOWSKI, Horae soc. ent. Rossicæ **19**: 27, pl. 4, fig. 28, male.
1897. *Mutilla luzonica* DALLE TORRE, Cat. Hymen. **8**: 55, male.
1899. *Mutilla luzonica* ANDRÉ, Ann. soc. ent. France **68**: 31, male. (Redescription of type.)
1903. *Mutilla luzonica* ANDRÉ, Gen. Ins. **1**, fasc. 11: 40, male.
1906. *Mutilla luzonica* BROWN, Philip. Journ. Sci. **1**: 689, male.

*Holotype.*—LUZON, male; in Musée Physiographique de l'Académie Polonaise des Sciences Cracovie, Krakow, Poland.

*Specimen examined.*—LUZON, male, Los Baños, March, 1917 (*F. X. Williams*); 6 males, Los Baños (*Baker*); 3 males, Los Baños (*G. Villegas*); 2 males, Los Baños; 12 males, Mount Maquiling (*Baker*); male, Manila (*R. C. McGregor*); male, Manila; male, Baguio, Benguet.

The holotype of this species in the Krakow Museum has been examined and the specimens placed here are identical with it. The species may be recognized at once by the long first flagellar segment (distinctly longer than the second), the form of the clypeus (median area of clypeus prominently, bluntly elevated along the median, longitudinal line and the ridge so formed terminating anteriorly in a prominent, submarginal, blunt tooth), and the form of the carina of the first abdominal sternite (conspicuously elevated posteriorly, the elevation broadened, transversely compressed and with the apex squarely truncate). The typical subspecies (material placed here) is distinguished from the following subspecies by the number of ferruginous abdominal segments and the form of the uncus of the genitalia. Genitalia mounted on slide No. 16. The female is unknown but may be *ovatula* subsp. *aurifera* described hereafter.

**TIMULLA (TROGASPIDIA) LUZONICA subsp. PANAYENSIS subsp. nov. Plate 1, fig. 10.**

*Male.*—Head, thorax, legs, first abdominal segment anteriorly, and last three abdominal segments, black; first abdominal segment posteriorly, second, third, and fourth segments, ferruginous; median area of clypeus with a thick, blunt ridge along the median, longitudinal line, the ridge terminating before the anterior margin in a thick, blunt tooth; first segment of flagellum slightly compressed, distinctly longer than the second; last abdominal tergite with a median, glabrous, tumescent area, rounded off posteriorly, not terminating in a tubercle; area on last tergite posterior to tumescent area slightly elevated along the median line, gently sloping to the lateral margins, with very small, close punctures; median carina of first sternite well developed, high, strongly elevated posteriorly into a prominent tooth, the tooth broadened, transversely compressed, and squarely truncate at the tip. Length, 17 millimeters.

*Holotype.*—Male, catalogue No. 49338, United States National Museum, PANAY, Culasi, 1918 (*McGregor*).

*Paratypes.*—PANAY, 6 males, northwestern part (*Baker*). NEGROS, 2 males, Cuernos Mountains. SIBUYAN, 13 males (*Baker*).

This subspecies is almost exactly like subspecies *luzonica* externally, with the exception of the color of the abdominal segments. The uncus of the genitalia is distinctly different, as illustrated. The genitalia are mounted on slide No. 17. The female of this subspecies is unknown but is probably *ovatula* described below.

### TIMULLA (TROGASPIDIA) OVATULA subsp. OVATULA sp. et subsp. nov.

*Female.*—Head, abdomen, and legs black, the thorax entirely ferruginous; second abdominal tergite with a pair of elongate-ovate, pale pubescent spots, the latter not extending on to the posterior half of the tergite, about twice as long as broad, and separated by slightly more than one and one-half times their transverse diameter; third tergite with a broad, complete band of pale pubescence; pygidial area longitudinally striated only on the anterior half, the posterior half granulated. Length, 9 millimeters.

Head entirely black, except the antennal tubercles and the flagellum beyond segment two tinged with ferruginous, the front and genæ clothed with long, sparse, suberect, pale fuscous pubescence, except the posterior margin of the vertex with a band of dense, appressed, pale pubescence; genæ with sparse, erect and appressed, pale pubescence; mandibles slender, edentate at the apex and with a small tooth within near the apex; clypeus elevated posteriorly, the elevated posterior margin slightly arcuate, and with a small tubercle medially immediately posterior to the elevated margin; antennal tubercles approximate; scape with small, sparse, shallow punctures, and sparse, pale pubescence; first segment of flagellum almost twice the length of the second; antennal scrobes strongly carinate above; front, vertex, and genæ with moderately large, dense, deep, confluent punctures, those on the genæ somewhat less coarse than on the front and vertex; relative widths of head and thorax, 4.0: 3.6.

Thorax entirely ferruginous, the dorsum clothed with sparse, erect and recumbent, dark ferruginous pubescence; humeral angles distinctly angulate; lateral margins of pronotum with a distinct tubercle just behind the middle; lateral margins of mesonotal area sinuate, slightly converging posteriorly; dorsum of thorax densely, deeply, longitudinally rugose-punctate; scutellar scale broad and distinct; dorsum of propodeum strongly reticulate, rounded into the posterior face of propodeum, the sculpture becoming longitudinally rugose on the anterior half of the posterior face, punctate with moderate, scattered punctures on the posterior half; posterior face of propodeum clothed with sparse, erect, pale pubescence; lateral margins of posterior face of propodeum denticulate; pleural areas throughout closely micropunctate and micropubescent.

Abdomen entirely black; first tergite glabrous, with small, scattered punctures and sparse, erect, pale hairs, except the posterior margin with a band of dense, appressed, black pubescence; second tergite clothed with dense, appressed, black pubescence, and scattered, erect, dark hairs, except the posterior two-thirds of the lateral margins broadly, with dense, appressed, pale pubescence, and a pair of elongate-ovate spots of dense, appressed pale pubescence on the anterior half (not extending on to the posterior half at all); the pale spots about twice as long as broad and separated by slightly more than one and one-half times their transverse diameter; apical fringe of second tergite entirely black except at the posterolateral angles; third tergite with a broad, complete band of dense, appressed, pale pubescence; fourth and fifth tergites clothed with thick, short, black pubescence and sparse, erect, dark hairs interspersed with pale fuscous hairs; anterior margin of pygidial tergite with black pubescence, the marginal areas adjoining the pygidium with pale, erect pubescence; pygidium longitudinally striate on the anterior half, granulate on the posterior half; first sternite with a median, longitudinal carina on the anterior two-thirds, the carina strongly, bluntly elevated posteriorly; second sternite glabrous, with moderate, very sparse punctures, finely, closely punctate at the posterior and lateral margins; second and third sternites each with a band of thick, appressed, pale pubescence at the apical margin; sternites three to five with small punctures, becoming close at the posterior margin of each; sternites four and five with a thin, apical fringe of pale hairs; hypopygium with small, close punctures and sparse, erect, pale hairs.

Legs entirely black, sparsely clothed with pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49339, United States National Museum, SIBUYAN (*Baker*).

*Paratypes.*—SIBUYAN, 2 females (*Baker*).

This species is easily recognizable by the unusually elongate, pale pubescent spots of the second abdominal tergite and the sculpture of the pygidium. These females from Sibuyan are the only ones in the material before me that may possibly be associated with the thirteen male specimens of *luzonica* subsp. *panayensis* from the same island. I think it likely that *ovatula* is the female of *panayensis*.

### TIMULA (TROGASPIDIA) OVATULA subsp. AURIFERA subsp. nov.

1869. *Mutilla Philippinensis* SICHEL and RADOSKOWSKI, Horae soc. ent. Rossicae 6: 226–227, female.

*Female.*—Head, abdomen, and legs black; thorax ferruginous; second abdominal tergite with a pair of elongate-ovate, distinctly golden pubescent spots, the latter extending slightly but distinctly onto the posterior half of the tergite, about twice as long as broad, and separated by approximately their own transverse diameter; third tergite with a broad band of dense, appressed, golden pubescence; pygidium longitudinally striated, the striæ not extending to the posterior margin, the posterior fourth of the pygidium faintly granulate. Length, 6 millimeters.

Front and vertex densely, longitudinally rugose-punctate, clothed with sparse, erect and suberect, pale fuscous pubescence; genæ with thick, appressed, pale pubescence; relative widths of head and thorax, 2.7: 2.3.

Second abdominal tergite with the scattered, erect hairs pale, and the very thin, apical fringe also pale; the golden, elongate spots of second tergite more posterior in position than the pale spots in typical *ovatula;* pygidial area with striæ extending more posteriorly than in typical *ovatula*, only the posterior fourth of pygidium weakly granulate.

*Holotype.*—LUZON, female, Balbalan; in collection of University of Minnesota.

*Paratype.*—LUZON, female, Ripang.

This subspecies is very similar to subspecies *ovatula* except as noted above. It may be easily recognized by the shape, color, and position of the pubescent spots on the second tergite and the striation of the pygidium. The description given for *philippinensis* by Sichel and Radoskowski corresponds to the specimens described here, and a specimen labeled *"philippinensis"* by Radoskowski, in the Krakow Museum, has been examined and is identical with the above holotype; therefore, the synonymy given above. This is probably the female of *luzonica* Radoskowski.

**TIMULLA (TROGASPIDIA) DEPRESSULA sp. nov.**

1895. *Mutilla suspiciosa* BINGHAM, Ann. & Mag. Nat. Hist. VI 16: 440–441, male (in part) (nec Smith).

*Male.*—Head, thorax, first, and last four abdominal segments, and legs black; abdominal segments two and three ferruginous; first segment of flagellum distinctly longer than the second; median area of clypeus elevated into a low, broad, blunt ridge terminating before the anterior margin; at least the first four abdominal segments clothed with sparse, very pale pubescence; posterior third of last tergite separated from the anterior two-thirds by a distinct, transverse depression extending the full width of the tergite; glabrous, tumescent area of last tergite distinctly triangular; carina of first sternite not broadened at posterior elevation. Length, 17 millimeters.

Head entirely black; front and anterior part of vertex clothed with sparse, erect, black pubescence, the front also with thick, recumbent, pale pubescence; posterior part of vertex with the erect pubescence pale fuscous; genæ with sparse, erect, and sparse, appressed, pale pubescence; mandibles strongly excised beneath forming a distinct tooth near the base, edentate at the tips and with a small, distinct tooth within near the tip; median area of clypeus glabrous, impunctate, except a few punctures between the termination of the median ridge and the anterior margin; median area of clypeus elevated as described above; scape with sparse, small punctures, and sparse, pale pubescence, bicarinate beneath, the ventral carina sharp and more distinct than the dorsal carina; first segment of flagellum slightly compressed and distinctly longer than the second; antennal scrobes distinctly carinate above; front and vertex with moderately large, close, somewhat confluent punctures, a small, elongate area adjacent and posterior to the lateral ocelli, impunctate; genæ with similar punctures, but closer and more confluent, the punctures sparse adjacent to the eye margins; relative widths of head and thorax at the tegulæ, 6.1: 6.7.

Thorax entirely black; pronotum with large, close, somewhat confluent punctures, clothed with sparse, erect, pale pubescence; mesonotum with large, deep, distinct punctures, clothed with sparse, erect, black pubescence; parapsidal furrows deep and distinct on the posterior three-fourths; scutellum elevated, and with a glabrous, impunctate, broad, sulcate, median, longitudinal line on the anterior half, the line terminating at the apex of the elevation; scutellum with very large, dense, deep, confluent punctures, clothed with sparse, erect, black pubescence; dorsum and posterior face of propodeum reticulate, the dorsum with sparse, erect, and sparse, appressed, pale pubescence, the posterior face with only sparse, erect, pale pubescence; lateral margins of dorsum of propodeum defined by a raised, glabrous line; inclosed area of dorsum of propodeum a very elongate triangle, about two and one-half times as long as broad at the base, the sides slightly sinuate, the apex elevated into a small tubercle, and with a median, longitudinal, raised line within; posterior face of propodeum with a median, longitudinal carina extending from the tip of the dorsal inclosed space to the posterior margin; propleuræ coarsely, longitudinally rugose-striate; mesopleuræ elevated ventrally and dorsally, the two elevated areas separated by an oblique furrow, the ventral elevated area much larger than the dorsal; elevated areas of mesopleuræ with large, dense, confluent punctures, and clothed with sparse, erect and sparse, appressed, pale pubescence, the anterior and posterior marginal areas only micropunctate and micropubescent; metapleuræ micropunctate and micropubescent except for large, shallow punctures ventrally; anterior half of sides of propodeum micropunctate and micropubescent, the posterior half shallowly reticulate; tegulæ large, glabrous, impunctate, except the anterior and inner margins punctate and black pubescent.

Abdomen black, except the posterior margin of the first, and the second and third entirely ferruginous, the first four segments clothed with sparse, erect, very pale pubescence, the fifth with intermixed pale and black pubescence, and the remainder with black pubescence; first tergite with moderate, scattered punctures; second tergite with a large, median area glabrous, impunctate, the lateral areas of the anterior two-thirds with moderate, distinct punctures, the posterior third of the tergite with very sparse, small punctures; tergites three to six with sparse, small punctures; last tergite with a median, triangular, glabrous, tumescent area on the anterior two-thirds, the posterior third separated from it by a distinct transverse depression at the posterior margin of the tumescent area; posterior third of last tergite with the lateral margins elevated, glabrous, and the median area obscurely, finely punctate; first sternite with a prominent, high carina on the anterior two-thirds, the carina conspicuously elevated posteriorly but the elevation not transversely compressed; second sternite with large, sparse, shallow punctures; sternites three to six with moderate, close punctures towards the lateral and posterior margins; seventh sternite, with a pair of small, distinct tubercles at the posterolateral angles; hypopygium with a pair of lateral, glabrous, almost parallel ridges on the anterior three-fifths, the ridges very widely separated, the space between with small, close punctures.

Wings dark fuscous with violaceous reflections; cell 2d $R_1 + R_2$ squarely truncate at the apex, equal in length to cell $R$ + 1st $R_1$; cell $R_5$ receiving vein $M_{3+4}$ slightly beyond the middle; cell $R_4$ present but less distinct than $R_5$ and receiving vein $M_2$ distinctly beyond the middle.

Legs black, clothed with sparse, erect and appressed, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49340, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, 2 males, Los Baños (*Baker*); 3 males, Mount Maquiling (*Baker*); 5 males, Mount Banahao (*Baker*); male, Bangui, November, 1923; male, Lamao, September, 1912 (*W. Schultze*); male, Nueva Vizcaya; male, Cape Engaño (*Whitehead*).

This species resembles *luzonica* superficially but is easily distinguished from the latter by the form of the pygidial tergite and the lower median ridge of the clypeus, as well as the carina of the first sternite, the posterior elevation of which is not transversely compressed. One of the specimens recorded by Bingham as *suspiciosa* belongs here. Specimens vary in length from 13 to 17 millimeters and in some specimens the first abdominal segment is almost entirely ferruginous.

### TIMULLA (TROGASPIDIA) BAKERI sp. nov.

*Male.*—Head, thorax, first and last four abdominal segments, and legs black; second and third abdominal segments ferruginous; median area of clypeus with a median, broad, blunt, elevated ridge terminating before the apical margin; first segment of flagellum distinctly longer than the second; tumescent area of last tergite subovate, the sides almost parallel; posterior third of last tergite not separated from the anterior two-thirds by a transverse depression, but with the lateral margins glabrous and elevated, and with small, distinct punctures; first four abdominal segments clothed with sparse, distinctly fulvous pubescence, the remaining segments with black pubescence; first abdominal sternite with a median longitudinal carina on the anterior two-thirds, the carina elevated posteriorly, the elevation not transversely compressed. Otherwise as in *depressula*. Length, 17 millimeters.

*Holotype.*—Male, catalogue No. 49341, United States National Museum, MINDANAO, Kolambugan (*Baker*).

*Paratypes.*—SAMAR, male, June 10, 1924 (*R. C. McGregor*); male, Catbalogan; 29 males (*Baker*). MINDANAO, 12 males, Surigao (*Baker*); male, Tangkulan, Bukidnon (*Baker*); 5 males, Iligan (*Baker*); 3 males, Kolambugan (*Baker*); 21 males, Dapitan (*Baker*); male, Mati, Davao, March, 1927 (*McGregor*); 3 males, Davao (*Baker*); male, Zamboanga (*Baker*). BASILAN, 5 males (*Baker*).

This species is very closely related to *depressula*. It differs in external characters as defined above and is not difficult to distinguish. On account of the differences in external characters as well as genitalia characters, I have preferred to give it specific rather than subspecific rank. The unci of the genitalia are very distinct in the two species. The specimens vary in length from 13 to 19 millimeters; a few specimens have the first abdominal segment ferruginous and occasionally the third segment is tinged with ferruginous.

### TIMULLA (TROGASPIDIA) TEGULARIA sp. nov.

*Male.*—Head, thorax, last three abdominal segments, and legs black; first four abdominal segments ferruginous; clypeus concave, with a prominent, transverse, submarginal carina anteriorly; tegulæ with small, close punctures and clothed with black pubescence; fifth abdominal tergite with a broad, apical band of thick, appressed, pale pubescence. Length, 12 millimeters.

Head black, clothed throughout with sparse, erect, pale pubescence, the front anteriorly also with thick, recumbent, pale pubescence; mandibles deeply excised beneath, thus with a strong tooth beneath near the base, edentate at the apices; clypeus concave, glabrous, with a prominent, anterior, submarginal carina as described above, the median, submarginal area thus formed, with moderate punctures; scape distinctly bicarinate beneath, with small, close punctures and sparse, pale pubescence; first segment of flagellum almost subequal in length to the second, only very slightly longer than the second; antennal scrobes distinctly carinate above; front and vertex with moderate, the genæ with moderately small, dense, confluent punctures throughout; relative widths of head and thorax at the tegulæ, 4.1 : 4.5.

Thorax black; pronotum with moderate, dense, confluent punctures, clothed with dense, appressed, pale pubescence; mesonotum with moderate, close, deep punctures, clothed with sparse, erect, black pubescence, the parapsidal furrows present and distinct on the posterior two-thirds; scutellum only moderately elevated, the anterior half with a median, longitudinal, glabrous line terminating at the apex of the elevation; scutellum with moderate, dense, deep, confluent punctures, the anterior half with black, the posterior half with pale, sparse, erect pubescence; dorsum and posterior face of propodeum reticulate, the reticulations broader on the dorsum than on the posterior face; both the dorsum and posterior face of propodeum with sparse, erect, pale pubescence, the dorsum also with thick, appressed, pale pubescence; lateral margins of dorsum of propodeum defined by a raised glabrous line; inclosed, median space of dorsum of propodeum elongate, subtriangular, about three times as long as it is broad at the base, the apex elevated into a small tubercle; propleuræ longitudinally rugose-punctate, the anterior margin defined by a carina; mesopleuræ elevated ventrally and dorsally, the ventral elevation largest in area, the two separated by an oblique furrow; elevated areas of mesopleuræ with moderate, dense, deep, confluent punctures and sparse, erect, as well as thick, recumbent, pale pubescence; anterior and posterior marginal areas of mesopleuræ micropunctate; metapleuræ micropunctate and micropubescent, except ventrally with moderate, distinct punctures; anterior half of sides of propodeum micropunctate and micropubescent, the posterior half narrowly reticulate; tegulæ large, convex, with fine, close punctures and sparse, recumbent, black pubescence throughout, except a narrow outer marginal area impunctate and bare.

First four abdominal segments ferruginous; remainder of abdomen black; first four abdominal segments with sparse, erect, pale pubescence; fifth tergite with a broad, complete, apical band of thick, appressed, pale pubescence; remaining segments with sparse, black pubescence, except the apical fourth of the last tergite and sternite with pale pubescence; first tergite with moderate punctures, scattered anteriorly, becoming close posteriorly; second tergite slightly transversely gibbose, the median area practically impunctate, the lateral areas with moderate, close, mostly distinct punctures; tergites three and four with small, sparse punctures; tergite five with small, close punctures;

tergite six with fine, very close punctures, last tergite with very small, close but distinct punctures, and with a median, longitudinal, glabrous ridge on the anterior three-fourths; first sternite with a median, longitudinal carina on the anterior two-thirds, scarcely elevated posteriorly; second sternite with an elongate, median area glabrous, impunctate, elsewhere with moderately large, close punctures; sternites three to six with small, close punctures at the posterior margin; seventh sternite with a pair of lateral, submarginal, glabrous ridges; hypopygium with a pair of lateral, parallel, glabrous, prominent ridges on the anterior half, the interspace with fine, distinct punctures.

Wings subfuscous; cell 2d $R_1 + R_2$ obscurely truncate at the apex, equal in length to cell R + 1st $R_1$; cell $R_5$ receiving vein $M_{3+4}$ at two-thirds the distance from base to apex; cell $R_4$ present but less distinct than $R_5$ and receiving vein $M_2$ at two-thirds the distance from base to apex.

Legs black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49342, United States National Museum, LUZON, Los Baños (*Baker*).

*Paratypes.*—LUZON, male, Los Baños, June–July, 1917 (*F. X. Williams*); male, Los Baños, July–August, 1917 (*F. X. Williams*); male, Los Baños, August, 1916 (*F. X. Williams*); male, Los Baños, 1916 (*F. X. Williams*); 4 males, Los Baños, 1917 (*F. X. Williams*); 25 males, Los Baños (*Baker*); 16 males, Mount Maquiling (*Baker*); 5 males, Malinao, Tayabas (*Baker*); 2 males, Manila, February, 1919 (*R. C. McGregor*); male, Manila, May, 1924 (*R. C. McGregor*); 2 males, Manila (*Robert Brown*); 2 males, Mount Banahao (*Baker*); male, Arayat, August, 1920 (*P. T.*). SIBUYAN, male (*Baker*). SAMAR, 4 males, Catbalogan; male (*Baker*). NEGROS, 10 males, Cuernos Mountains (*Baker*); male, Isabela Central, June 13, 1930 (*A. W. Lopez*). PANAY, male, Culasi, June (*R. C. McGregor*); male, Culasi, July 6, 1918 (*R. C. McGregor*). MINDANAO, 3 males, Butuan (*Baker*); 7 males, Dapitan (*Baker*); male, Davao (*Baker*).

This species is related to *pustulata* Smith from Japan, *elpinice* Mickel from Formosa, and the following species from Palawan. All have the same type of clypeus and pygidial tergite. *Timulla tegularia* differs from all of them in the closely punctate and black pubescent tegulæ. The paratypes vary in length from 8 to 12 millimeters. The fourth abdominal segment varies in color from ferruginous to black. As may be noted above the species is present in four of the geographic areas of the Philippine Islands. I have examined the specimens from the various areas critically but find no evidence externally or in the genitalia of subspecific differences.

### TIMULLA (TROGASPIDIA) TETHYS sp. nov.

*Male.*—Head, thorax, last two abdominal segments, and legs black; first five abdominal segments ferruginous; clypeus concave, with a transverse, anterior, submarginal, prominent carina; all of the abdominal tergites with sparse pubescence, none with a transverse band of appressed, pale pubescence. Length, 13 millimeters.

Head entirely black, clothed throughout with sparse, erect, pale pubescence, the front anteriorly and the genæ also with sparse, appressed, pale pubescence; mandibles deeply excised beneath, thus with a strong tooth beneath near the base, edentate at the apex and with a small tooth within near the apex; clypeus as described above, like that in *tegularia;* scape distinctly bicarinate beneath, with small, close punctures and sparse, pale pubescence; first segment of flagellum subequal in length to the second, only very slightly longer than the latter; antennal scrobes distinctly carinate above; front and vertex with moderately large, dense, shallow, confluent punctures; genæ with moderate, dense, confluent punctures; relative widths of head and thorax at the tegulæ, 4.6 : 4.9.

Thorax entirely black; pronotum with moderately large, dense, confluent punctures, clothed with sparse, erect, and sparse, appressed, pale pubescence; mesonotum with moderately large, close, confluent punctures, clothed with sparse, erect, black pubescence; the parapsidal furrows present and distinct on the posterior two-thirds; scutellum moderately convexly elevated, with moderately large, dense, deep, confluent punctures, the anterior half with a median, longitudinal, raised, glabrous line terminating at the apex of the elevation, clothed on the anterior half with sparse, black pubescence, on the posterior half with sparse, pale pubescence; dorsal and posterior faces of propodeum reticulate, the reticulations broader on the dorsum than on the posterior face; both dorsum and posterior face with sparse, erect, pale pubescence, the dorsum also with somewhat thick, recumbent, pale pubescence; lateral margins of dorsum of propodeum defined by a raised glabrous line; inclosed area of dorsum of propodeum elongate, about two and one-half times as long as broad, the apex elevated into a slight tubercle; propleuræ longitudinally rugose-punctate, the anterior margin defined by a carina; mesopleuræ convexly elevated ventrally and dorsally, the two elevated areas separated by an oblique furrow, with moderately large, dense, confluent punctures and sparse, erect and appressed, pale pubescence; anterior and posterior marginal areas of mesopleuræ micropunctate; metapleuræ micropunctate and micropubescent, except ventrally with moderately large, shallow punctures; anterior third of sides of propodeum micropunctate and micropubescent, the posterior two-thirds reticulate; tegulæ large, convex, glabrous, impunctate, except the anterior and inner margins punctate and black pubescent.

First five abdominal segments ferruginous, and clothed with very sparse, pale pubescence; remainder of abdomen black, clothed with sparse, black pubescence above, sparse, pale pubescence beneath; first tergite with moderately large, sparse, shallow punctures, becoming closer posteriorly, and with a few small punctures at the posterior margin; second tergite slightly transversely gibbose, the median area glabrous, practically impunctate, the lateral areas with moderate, distinct, close punctures; tergites three to six with small, very sparse punctures; pygidial tergite with small, dense, confluent punctures except medially a longitudinal, glabrous ridge on the anterior three-fourths, the ridge terminating in a slight tubercle; first sternite with a median, longitudinal carina on the anterior two-thirds, scarcely elevated posteriorly; second sternite with a median, elongate, impunctate, glabrous area, and laterally with moderately large, distinct, shallow punctures; sternites three to six with small, close punctures towards the posterior margin; seventh sternite with a pair of lateral, submarginal, low, glabrous ridges; hypopygium with a pair of lateral, prominent, glabrous ridges on the anterior half, terminating posteriorly in a small, distinct, posteriorly directed tooth, the interspace with small punctures.

Wings subfuscous; cell 2d $R_1 + R_2$ squarely truncate at the apex, equal in length to cell R + 1st $R_1$; cell $R_5$ receiving vein $M_{3+4}$ at two-thirds the distance from base to apex; cell $R_4$ present but less distinct than $R_5$ and receiving vein $M_2$ at two-thirds the distance from base to apex.

Legs black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49343, United States National Museum, PALAWAN, Puerto Princesa (*Baker*).

*Paratypes.*—PALAWAN, 7 males, Puerto Princesa (*Baker*).

Related to *tegularia* but differs in the impunctate, glabrous tegulæ, the absence of any band of appressed, pale pubescence on the abdominal tergites, and by having the first five abdominal segments ferruginous. It is very similar to *elpinice* Mickel from Formosa but has the hypopygial ridges much more strongly developed than the Formosa species, while the latter has a band of appressed, pale pubescence on the fourth abdominal tergite; *pustulata* Smith from Japan differs in having only the first two abdominal segments ferruginous and in having pale pubescent bands on tergites three and four. Paratypes vary in length from 9 to 12 millimeters.

TIMULLA (TROGASPIDIA) MANILENSIS (Brown).

1906. *Mutilla manilensis* BROWN, Philip. Journ. Sci. 1: 685, female.

*Type.*—Female, Manila. Location of type specimen unknown.

*Specimens examined.*—LUZON, female, Los Baños, July–August, 1917 (*F. X. Williams*); female, Los Baños, August, 1916 (*F. X. Williams*); female, Los Baños, 1917 (*F. X. Williams*); 7 females, Los Baños (*Baker*); 6 females, Mount Maquiling (*Baker*); female, Mount Banahao (*Baker*); female, Manila, February, 1919, (*R. C. McGregor*); female, Manila (*Brown*); female, Manila, December 18, 1911 (*C. S. Banks*); female, Manila, December 22, 1905; female, Arayat, August, 1920; female, Baguio, June, 1917 (*F. X. Williams*); female, Trinidad, Benguet, December 3, 1907 (*C. S. Banks*); 2 females, Imugan, Nueva Vizcaya (*Baker*); female, Pagsan; female. PANAY, 2 females, Culasi, June (*R. C. McGregor*). NEGROS, female, Cuernos Mountains (*Baker*); female, La Carlota Central, September 26, 1929 (*A. W. Lopez*); female, Sicaba, February 15, 1928; female, Victorias, February 13, 1928. MINDANAO, female, Butuan (*Baker*); female, Kolambugan (*Baker*); 3 females, Dapitan (*Baker*); female, Davao (*Baker*). BASILAN, female (*Baker*). PALAWAN, female, Puerto Princesa (*Baker*).

I have not been able to locate a specimen that fulfils the requirements for the type of Brown's *manilensis*. The Philippine Bureau of Science has loaned me its collection for study but no specimen labeled or determined by Brown is in the material; neither is there any such specimen in the collections of the United States National Museum. A specimen in the Philippine Bureau of Science material determined as *manilensis* by someone other than Brown is obviously very different from the original description. I have considered all the possibilities; that is, all the species taken at Manila, the type locality of *manilensis*, and am certain that the material placed here is the species Brown described in spite of one discrepancy between these specimens and the original description. The length of the specimens and the pale maculations of the second tergite agree exactly with Brown's description, but the latter specifies "third and fifth segments covered with transverse bands of silvery pubescence." This is a puzzle since no species of the subgenus *Trogaspidia,* to which *manilensis* must be assigned on account of the maculation of the second tergite, known to me from the Philippines has the fifth abdominal segment with a band of pale pubescence. The species in this group known from the Philippines always have the fifth segment black. However, the base of the pygidial, or sixth segment, has rather thick, pale pubescence in the specimens placed here, and this is also true of most other species of *Trogaspidia* from the Philippines. My opinion is that Brown in writing the description mistook this pale pubescence of the sixth segment to be on the fifth. This seems all the more likely to me since Bingham (1895) made the same error in his description of females from Cape Engaño as the female sex of *suspiciosa* Smith. The only other possibility among species occurring at Manila is the female of *minor* Ashmead. The latter is evidently not the species Brown had before him since the spots on the second tergite are somewhat ovate, not round; in the specimens placed here the pale pubescent spots are small and round, which agrees with the original description.

*Timulla manilensis* is easily recognized by the sculpture of the pygidium, irregularly rugose on the anterior half and granulate on the posterior half, and by its small size. The specimens vary in length from 5 to 7.5 millimeters. There is also a variation in specimens from the same locality in the color of the antennal tubercles, most of them having the tubercles ferruginous, but a few, black.

The locality records of this species and of *tegularia* indicate the possibility that the latter is the male of *manilensis,* but there is no other evidence and I prefer to treat them as separate species for the present. However, if *tegularia* should prove to be the male of *manilensis,* then the specimen of the latter from Palawan must be the female of *tethys.* I have studied the Palawan specimen with this in mind but could find no basis for differentiating it from *manilensis.*

**TIMULLA (TROGASPIDIA) PROSERPINA subsp. PROSERPINA (Smith).**

1858. *Mutilla proserpina* SMITH, Journ. Proc. Linn. Soc., Zool. 2: 85. female.

1897. *Mutilla proserpina* DALLE TORRE, Cat. Hymen. 8: 74, female.

1903. .............. *proserpina* ANDRÉ, Gen. Ins. 1, fasc. 11: 71, female.

*Holotype.*—Female, Borneo, in Saunders's collection, University of Oxford, England.

*Specimens examined.*—PANAY, female, northwestern part (*Baker*). SIARGAO, female, Dapa. MINDANAO, 5 females, Surigao (*Baker*); female, Surigao; 6 females, Tangkulan, Bukidnon (*Baker*); 11 females, Iligan (*Baker*); 6 females, Kolambugan (*Baker*); 5 females, Dapitan (*Baker*); 2 females, Mumungan. BASILAN, 5 females (*Baker*).

The above specimens have been compared with specimens of *proserpina* from Borneo and found to be the same. These specimens, as well as Borneo specimens, vary in the extent of the ferruginous color on the first abdominal segment, some having that segment almost entirely ferruginous, others largely black; there is also some variation in the degree of development of the thin, apical fringe at the margin of the second tergite; most specimens have the fringe very thin and inconspicuous, but a few have the fringe well developed and distinct; the length of specimens varies from 4 to 8 millimeters.

### TIMULLA (TROGASPIDIA) PROSERPINA subsp. TIBIATA subsp. nov.

*Female.*—Head, abdomen, tips of femora, tibiæ and tarsi entirely, all black; antennal tubercles, scape, mandibles except the tips, thorax entirely, coxæ, trochanters, and femora except the tips, all ferruginous; scutellar scale present; second tergite with a pair of small, round, basal spots, and a thin, inconspicuous, apical fringe of pale pubescence; third tergite with a broad band of dense, appressed, pale pubescence; last tergite anteriorly and laterally with sparse, erect, pale pubescence; pygidial area entirely glabrous, unsculptured. Length, 6.5 millimeters.

*Holotype.*—Female, catalogue No. 49344, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, female, Los Baños, March, 1917 (*F. X. Williams*); female, Los Baños, March–June, 1925 (*Pemberton*); female, Los Baños, July–August, 1917 (*F. X. Williams*); female, Los Baños, August, 1916 (*F. X. Williams*); female, Los Baños, September, 1917 (*F. X. Williams*); 10 females, Los Baños (*Baker*); 16 females, Mount Maquiling (*Baker*); 2 females, Mount Banahao (*Baker*); female, Malinao, Tayabas (*Baker*); female, Bulbulan. SAMAR, female, (*Baker*). MINDANAO, female, Kolambugan, 1914 (*C. S. Banks*).

*Timulla proserpina* subsp. *tibiata* is practically the same as the subspecies *proserpina* except that the antennal tubercles and scape are a darker ferruginous, the first abdominal segment is entirely black, and the tips of the femora as well as the tibiæ and tarsi entirely are also black. When the male is discovered this may prove to be a distinct species. It is probable that the specimen labeled "Kolambugan, Mindanao" is incorrectly labeled. Other specimens from Kolambugan are the subspecies *proserpina.*

### TIMULLA (TROGASPIDIA) PROSERPINA subsp. SIBUYANENSIS subsp. nov.

*Female.*—Head and abdomen black; antennal tubercles, scape, flagellum beneath, mandibles except the tips, thorax entirely, coxæ, trochanters, and femora except the tips all pale ferruginous; tips of femora, tibiæ, and tarsi dark ferruginous; scutellar scale present; second tergite with a pair of linear spots extending from the anterior margin to the middle of the tergite, and a narrow apical margin of pale pubescence; third tergite with a broad band of dense, appressed, pale pubescence; last tergite anteriorly and laterally with sparse, erect, pale pubescence; pygidial area entirely glabrous, unsculptured. Length, 5.5 millimeters.

*Holotype.*—Female, catalogue No. 49345, United States National Museum, SIBUYAN (*Baker*).

*Paratype.*—SIBUYAN, female (*Baker*).

Very similar to *proserpina* but the tips of femora, tibiæ, and tarsi are darker than in the typical subspecies, but not as black as in the subspecies *tibiata;* also very distinct in the linear spots and narrow, apical, pale pubescent margin of the second tergite.

## SPECIES KNOWN ONLY IN THE MALE

The following species and subspecies are known only in the male sex. They differ from the foregoing males in having the scutellum evenly convex, not conically elevated; in having the hypopygium flat and plain, without any indication of ridges or tubercles; and in having the genitalia of the males bilaterally symmetrical. There is practically no variation in the male genitalia of the various species and subspecies.

### TIMULLA (TROGASPIDIA) IRA subsp. PALAWANA subsp. nov.

*Male.*—Head, thorax, last four abdominal segments, and legs black; first three abdominal segments ferruginous; median area of clypeus subtriangular, with a pair of obscure, submarginal tubercles near the anterolateral angles, clothed with sparse, pale pubescence; scutellum evenly convex, not at all elevated; tegulæ microreticulate; last abdominal tergite with a median, narrow, longitudinal, glabrous area on the posterior three-fourths; hypopygium unarmed; wings subfuscous. Length, 14 millimeters.

Head entirely black, clothed with sparse, erect and recumbent, pale pubescence, somewhat thicker on the front; mandibles deeply excised beneath, thus forming a tooth near the base beneath; median area of clypeus very slightly concave, glabrous, and as described above; scape strongly bicarinate beneath, with small, close punctures and sparse, pale pubescence; first segment of flagellum equal in length to the second; antennal scrobes carinate above; front, vertex, and genæ with moderate, dense, confluent punctures; relative widths of head and thorax including the tegulæ, 4.5 : 4.9.

Thorax entirely black; pronotum with moderately large, dense, confluent punctures, clothed with sparse, erect and appressed, pale pubescence; mesonotum with moderately large, close, distinct punctures, clothed with sparse, erect, dark fuscous pubescence, the parapsidal furrows present and distinct only on the posterior half; scutellum evenly, slightly convex, not at all elevated, with moderately large, dense, deep, confluent punctures, and clothed with sparse, erect, pale fuscous pubescence; dorsum and posterior face of propodeum rounded into one another, reticulate, clothed with sparse, erect, pale pubescence, and the dorsum with sparse, obscure, appressed, pale pubescence; inclosed space on dorsum of propodeum elongate, subtriangular, about one and one-half times as long as broad at the base, and with a very large reticulation each side at the base; lateral margins of dorsum of propodeum rounded into the sides; propleuræ micropunctate and micropubescent, the anterior margin defined by a carina; mesopleuræ medially with moderate, dense, confluent punctures, clothed with sparse, erect, and dense, appressed, pale pubescence, the anterior and posterior marginal areas micropunctate and micropubescent; metapleuræ micropunctate and micropubescent except ventrally a few scattered, moderate punctures; sides of propodeum micropunctate and micropubescent anteriorly, shallowly reticulate posteriorly; tegulæ large, convex, microreticulate throughout, and obscurely rugose, the anterior and inner margins punctate and pale pubescent.

First three abdominal segments ferruginous; remainder of abdomen black; first five abdominal segments clothed with very sparse, erect, very pale fulvous pubescence; last two abdominal segments clothed with sparse, black pubescence; first tergite with moderate punctures, scattered medially, close laterally; median area of second tergite with very sparse, small punctures, the lateral areas with moderate, distinct, somewhat close punctures; tergites three to six with moderately small, distinct, somewhat close punctures, except a narrow, median, longitudinal area on the posterior three-fourths glabrous, impunctate; first sternite with a median, longitudinal carina on the anterior two-thirds, not noticeably elevated posteriorly; second sternite with a median gibbosity on the anterior half, with sparse, moderate, distinct punctures throughout; remaining sternites and hypopygium with sparse, moderately small punctures.

Wings subfuscous; cell 2d $R_1 + R_2$ obliquely truncate at the tip, a little less than three times as long as broad, only slightly longer than cell R + 1st $R_1$; cell $R_5$ receiving vein $M_{3+4}$ at about two-thirds the distance from base to apex; cell $R_4$ present but less distinct than $R_5$ and receiving vein $M_2$ slightly beyond the middle.

Legs black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype*.—Male, catalogue No. 49346, United States National Museum, PALAWAN, Puerto Princesa (*Baker*).

This subspecies differs from typical *ira* Cameron in the distinctly paler wings, ferruginous third abdominal segment and less-dense puncturation of the mesonotum. Specimens of the subspecies *palawana* have been compared with specimens of *ira* from Borneo. The two are alike except for the above differences. Thirty-two specimens of *ira* are before me from Borneo, all of which have distinctly darker wings and denser puncturation than the Palawan specimens. The genitalia of the two are apparently the same.

### TIMULLA (TROGASPIDIA) TEMERARIA sp. nov.

*Male*.—Head, thorax, last five abdominal segments, and legs black; first two abdominal segments ferruginous; first segment of flagellum slightly shorter than the second; pronotum with moderate, close, somewhat confluent punctures; scutellum evenly, slightly convex, not elevated; tegulæ with small punctures and sparse, pale pubescence throughout; first five abdominal segments clothed with sparse, pale pubescence, except the fifth with the thin, apical fringe black; cell $R_4$ of wings practically obsolete. Length, 13 millimeters.

Head entirely black, clothed throughout with sparse, erect, pale pubescence except the front medially with thick, appressed, pale pubescence, and the genæ with short, sparse, thick, pale pubescence; mandibles deeply excised beneath, thus with a strong tooth beneath near the base, slender, edentate at the tips and with a small tooth within near the tips; clypeus without a distinct median area, bluntly elevated along the median line and with a small, transverse concavity medially between the anterior margin and the anterior terminus of the ridge; apical half of median clypeal ridge glabrous, bare, the median, apical concavity glabrous and very sparsely pubescent, the remainder of clypeus finely punctate and pale pubescent; scape with a single, strong carina beneath, with small, close punctures and sparse, pale pubescence; first segment of flagellum slightly shorter than the second; antennal scrobes carinate above; front with moderate, close, confluent punctures, the vertex with moderate, separated punctures, the genæ with small, shallow, well-separated punctures; relative widths of head and thorax at the tegulæ, 4.2: 4.4.

Thorax entirely black; pronotum with moderate, dense, confluent punctures, clothed with sparse, erect, pale pubescence, the posterior margin with thick, appressed, pale pubescence; mesonotum with moderate punctures in part separated, in part close and confluent, clothed with sparse, erect, black pubescence; scutellum evenly, slightly convex, not elevated, with moderate, dense, confluent punctures and sparse, erect, pale pubescence; dorsum of propodeum rounded into the posterior face, both reticulate throughout, the reticulations larger on the dorsum, clothed with sparse, erect, pale pubescence, the dorsum also with short, recumbent, obscure, pale pubescence; inclosed space of dorsum of propodeum elongate, about three times as long as broad, the sides sinuate; dorsum of propodeum rounded laterally into the sides of propodeum; posterior face of propodeum with a median, longitudinal carina its entire length; propleuræ with small, scattered punctures and also micropunctate and micropubescent, the anterior margin defined by a carina; ventral and dorsal areas of mesopleuræ evenly convex, separated by an oblique furrow, with moderate, close, shallow punctures and thick, appressed as well as sparse, erect, pale pubescence; anterior and posterior marginal areas of mesopleuræ micropunctate and micropubescent, the posterior area also with scattered, small, shallow punctures; metapleuræ micropunctate and micropubescent, ventrally with a very few, moderate punctures; posterior three-fifths of sides of propodeum reticulate, the anterior two-fifths micropunctate and micropubescent; tegulæ with sparse, small punctures throughout, the punctures closer towards the anterior and inner margins, clothed with sparse, recumbent, pale pubescence.

First two abdominal segments ferruginous, the remainder of the abdomen black; the first five abdominal segments clothed with sparse, suberect, pale pubescence, the last two segments clothed with black pubescence; first tergite with sparse, moderate punctures throughout; second tergite with moderate punctures, somewhat sparse medially, close laterally, and becoming small at the posterior margin; tergites three to six with moderate, well-separated punctures on the third and more separated medially than laterally, becoming smaller and sparser until the sixth with small, sparse punctures; last tergite with small, close, distinct punctures, and with a narrow, almost obsolete, median, longitudinal ridge on the anterior two-thirds, only very slightly elevated posteriorly; second sternite with moderate, distinct, close punctures throughout; sternites three to six with small, close, distinct punctures posteriorly on three and four, with small, sparse, distinct punctures on five and six; hypopygium with small punctures, some close to one another, others sparse.

Wings subfuscous; cell 2d $R_1 + R_2$ distinctly longer than cell $R$ + 1st $R_1$, the former about two and one-half times its greatest breadth, narrowly, obliquely truncate at the apex; cell $R_5$ receiving vein $M_{3+4}$ distinctly beyond the middle; cell $R_4$ practically obsolete.

Legs entirely black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49347, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, male, Los Baños, July–August, 1917 (*F. X. Williams*); male, Los Baños, 1916 (*F. X. Williams*); male, Los Baños, March–June, 1925 (*Pemberton*); 3 males, Los Baños (*G. Villegas*); 28 males, Los Baños (*Baker*); 47 males, Mount Maquiling (*Baker*); 6 males, Mount Banahao (*Baker*); male, Bangui, Ilocos Norte, May 15, 1911 (*C. S. Banks*); male.

The paratypes vary in length from 7 to 13 millimeters. Easily recognized by the characters indicated in the key. Some of the paratypes have the anterior portion of the first abdominal segment tinged with black.

### TIMULLA (TROGASPIDIA) FORTUITA sp. nov.

*Male.*—Black, except the first three abdominal segments ferruginous; pronotum and mesonotum with small, sparse, shallow punctures; scutellum with moderate, shallow, separated punctures; abdominal tergites one to five clothed with pale pubescence, the remaining abdominal segments with black pubescence; outer, posterior fourth of tegulæ glabrous, impunctate. Length, 10 millimeters.

Head entirely black, the front medially with thick, appressed and sparse, erect, pale pubescence, the front laterally, the vertex and the genæ, all with sparse, erect, pale pubescence, except the genæ at the posterior margin of the eyes also with thick, appressed, pale pubescence; mandibles deeply excised beneath forming a distinct tooth beneath near the base, edentate at the apex and with a small tooth within near the apex; subtriangular median area of clypeus moderately elevated, and with an obscure, median, longitudinal ridge on the posterior half, the latter also pale pubescent, the anterior half mostly glabrous, bare; scape strongly bicarinate beneath, elsewhere with fine, separated punctures and sparse, pale pubescence; first segment of flagellum slightly but distinctly shorter than the second; antennal scrobes distinctly carinate above; front with moderate, shallow, separated punctures; vertex with moderately small, shallow, sparse punctures; genæ with small, shallow, sparse, obscure punctures; relative widths of head and thorax including the tegulæ, 3.5 : 3.7.

Thorax entirely black; pronotum with small, sparse, shallow punctures, clothed with sparse, pale pubescence, the latter thick and appressed at the posterior margin; mesonotum with moderately small, sparse punctures, clothed with sparse, dark fuscous, almost black, pubescence; parapsidal furrows distinct on the posterior half of mesonotum; scutellum convex, with moderate, shallow, separated but close punctures, clothed with sparse, erect, pale pubescence; dorsum and posterior face of propodeum rounded into one another, shallowly reticulate, clothed with sparse, erect, pale pubescence, the dorsum also with sparse, short, appressed, pale pubescence; lateral margins of dorsum of propodeum not defined, the median inclosed space triangular, elongate, three times as long as broad at the base, not elevated at the apex; propleuræ micropunctate and micropubescent, the anterior margin defined by a weak carina; mesopleuræ convex, the median area from venter to dorsum with moderate, separated, shallow punctures and clothed with sparse, erect, and thick, appressed, pale pubescence, the anterior and posterior areas micropunctate and micropubescent; metapleuræ micropunctate and micropubescent, with a few, moderate. punctures ventrally; sides of propodeum micropunctate and micropubescent on the anterior half, the posterior half shallowly reticulate; tegulæ convex, the inner half and anterior margin punctate and pale pubescent, the outer, posterior fourth glabrous, impunctate.

First three abdominal segments ferruginous, remainder of abdomen black; first five abdominal segments with sparse, erect, pale pubescence, the remainder with sparse, erect, black pubescence; first tergite with moderately small, shallow punctures; second tergite with fine, very sparse punctures, except the anterolateral areas with small, distinct punctures; tergites three to six with small, sparse punctures, the punctures on the anterior tergites of this somewhat larger than those on the posterior tergites; last tergite with small, sparse punctures and a median, longitudinal, glabrous, obscurely elevated ridge on the posterior half; first sternite with a median, longitudinal carina on the anterior two-thirds, the carina not elevated posteriorly; second sternite with moderate, sparse punctures; sternites three to six with moderately small, sparse punctures; hypopygium with small, sparse punctures.

Wings subfuscous; cell 2d $R_1 + R_2$ distinctly longer than cell R + 1st $R_1$, the former very slightly more than twice as long as broad, almost squarely truncate at the apex; cell $R_5$ receiving vein $M_{3+4}$ slightly beyond the middle; cell $R_4$ practically obsolete.

Legs entirely black, sparsely clothed with pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49348, United States National Museum, MINDANAO, Tangkulan, Bukidnon (*Baker*).

*Paratypes.*—SIBUYAN, 4 males (*Baker*). NEGROS, 3 males, Cuernos Mountains (*Baker*). MINDANAO, male, Butuan (*Baker*); 51 males, Tangkulan, Bukidnon (*Baker*); 8 males, Iligan (*Baker*); 2 males, Kolambugan, 1914 (*C. S. Banks*); 8 males, Kolambugan (*Baker*); 13 males, Dapitan (*Baker*); 9 males, Davao (*Baker*); 3 males, Zamboanga (*Baker*). BASILAN, 6 males (*Baker*). PALAWAN, male, Puerto Princesa (*Baker*).

This species is closely related to *temeraria* but differs in so many respects externally that I regard it as a distinct species. The paratypes vary in length from 7 to 13 millimeters. There is also some variation in the color of the third abdominal segment. Most specimens have the third segment entirely ferruginous but a few have the posterior third or the posterior half blackish, and one or two specimens have the third segment entirely blackish. In all cases, however, the puncturation of the pronotum and mesonotum is small and sparse, and the outer, posterior fourth of the tegulæ is glabrous, impunctate.

**TIMULLA (TROGASPIDIA) NIGERRIMA** sp. nov.

*Male.*—Entirely black; mandibles excised beneath; pronotum and mesonotum with moderate, shallow, sparse punctures; scutellum evenly convex, with moderate, shallow, close punctures; first five abdominal segments with sparse, pale pubescence; hypopygium plain without elevated ridges; outer, posterior fourth of tegulæ glabrous, impunctate. Length, 13 millimeters.

Head entirely black, the front medially with sparse, erect and thick, appressed, pale pubescence, the vertex and genæ with sparse, erect, pale pubescence, except the genæ with thick, appressed, pale pubescence adjoining the posterior eye margins; mandibles excised beneath forming a distinct tooth beneath near the base, edentate at the apex and with a small, distinct tooth within near the apex; median, subtriangular area of clypeus elevated, the posterior half with a median, longitudinal, obscurely elevated ridge and with pale pubescence, the anterior half mostly glabrous, impunctate; scape obscurely bicarinate beneath, the anterior carina almost obsolete, elsewhere with small, close punctures and sparse, pale pubescence; first segment of flagellum slightly but distinctly shorter than the second; antennal scrobes carinate above; front with moderate, shallow, close, more or less confluent punctures interspersed medially with small, distinct punctures; vertex with moderately small, sparse punctures; genæ with small, sparse punctures; relative widths of head and thorax at the tegulæ, 4.3: 4.7.

Thorax entirely black; pronotum with moderate, close, shallow punctures, clothed with sparse, erect and appressed, pale pubescence, except the appressed, pale pubescence thick at the posterior margin; mesonotum with moderate, distinct, sparse punctures, clothed with sparse, dark fuscous, almost black pubescence, except the anterior fifth with sparse, pale pubescence; parapsidal furrows distinct on posterior half of mesonotum; scutellum evenly convex, with moderately large, close, shallow punctures, clothed with sparse, erect, pale pubescence; dorsum, posterior face, and sides of propodeum all rounded into one another, the dorsum and posterior face distinctly reticulate, and clothed with sparse, long, erect, pale pubescence, the dorsum also with somewhat thick, short, appressed, pale pubescence; inclosed space of dorsum of propodeum elongate, subtriangular, about three times as broad as long; posterior face with a median carina extending from the apex of the inclosed area to the posterior margin; propleuræ defined anteriorly by a carina, micropunctate and micropubescent, and with a few, scattered, small punctures; mesopleuræ convex, the median area from ventral to dorsal margin with moderate, shallow, close punctures and somewhat thick, erect and appressed, pale pubescence; anterior and posterior areas of mesopleuræ micropunctate and micropubescent; metapleuræ micropunctate and micropubescent throughout, except moderately large, shallow punctures ventrally; anterior half of sides of propodeum micropunctate and micropubescent, the posterior half shallowly reticulate; tegulæ punctate and pale pubescent, except the outer, posterior fourth glabrous, impunctate, bare.

Abdomen entirely black, the first five segments with sparse, pale pubescence, the remainder with black pubescence; first tergite with sparse, small, shallow punctures, the latter becoming somewhat closer and more distinct posteriorly; second tergite with small, very sparse punctures, except the anterolateral areas with the punctures larger and closer though still well separated, and the posterior margin with the punctures closer; tergites three to six with small, sparse punctures; last tergite with small, distinct punctures, and with an obscure, median, longitudinal, glabrous ridge on the posterior half; first sternite with a median, longitudinal carina on the anterior two-thirds, only very slightly higher posteriorly than medially; second sternite with moderate sparse punctures; sternites three to six with moderate, distinct, separated punctures; hypopygium with small, separated punctures.

Wings fuscous with faint violet reflections; cell 2d $R_1 + R_2$ one and one-third times as long as cell R + 1st $R_1$, the former two and two-thirds times as long as broad; cell $R_5$ receiving vein $M_{3+4}$ distinctly beyond the middle; cell $R_4$ practically obsolete.

Legs entirely black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49349, United States National Museum, MINDANAO, Surigao (*Baker*).

*Paratypes.*—LUZON, male, Malinao, Tayabas (*Baker*). SAMAR, 10 males (*Baker*). BILIRAN, male, (*Baker*). MINDANAO, 18 males, Surigao (*Baker*) ; 2 males, Surigao; 3 males, Butuan (*Baker*).

Closely related to *fortuita* but differs in the puncturation of the body, in color, in the darker wings and its distinctly larger average size. The paratypes vary in length from 9 to 15 millimeters with most of them about 12 to 13 millimeters. The only other entirely black member of this genus likely to be confused with *nigerrima* is *sticticornis* subsp. *nigridia*, which may be recognized at once by the first segment of the flagellum being yellowish beneath. *Timulla philippinensis* subsp. *itambusa* is, of coarse, entirely black, but it is a much larger species in which the mandibles are not excised beneath.

### TIMULLA (TROGASPIDIA) STICTICORNIS subsp. STICTICORNIS sp. et subsp. nov.

*Male.*—Black, except the second abdominal segment almost entirely ferruginous, and the first two flagellar segments yellowish beneath; first segment of flagellum distinctly shorter than the second; scutellum evenly convex; first five abdominal segments clothed with sparse, pale pubescence, remainder of abdomen with black pubescence; wings subfuscous. Length, 12 millimeters.

Head black, the front clothed with sparse, erect, pale pubescence and medially with short, appressed, pale pubescence, the vertex with sparse, erect, pale pubescence, and the genæ with sparse, erect, pale pubescence as well as short, sparse, appressed, pale pubescence adjoining the posterior eye margins; mandibles deeply excised beneath forming a tooth beneath near the base, edentate at the tip and with a small tooth within near the apex; subtriangular median area of clypeus moderately elevated, the posterior half with a median, elevated ridge terminating anteriorly in a blunt tubercle, the median area largely glabrous, impunctate and bare, but punctate and pale pubescent laterally; scape obscurely bicarinate beneath, the anterior carina sharp and well developed, the posterior one almost obsolete, the scape elsewhere with small, close punctures and sparse, pale pubescence; first segment of flagellum distinctly shorter than the second, the ventral surface entirely yellowish; second flagellar segment with the proximal fourth of the ventral surface yellowish; antennal scrobes carinate above; front with moderately large, dense, shallow, confluent punctures; vertex with moderate, distinct, separated punctures; genæ with small, shallow, sparse punctures; relative widths of head and thorax at the tegulæ, 4.6: 4.9.

Thorax entirely black; pronotum with moderate, close, shallow punctures, clothed with sparse, erect and appressed, pale pubescence, the posterior margin with the appressed pubescence thick; mesonotum with moderate, distinct, separated punctures, clothed with sparse, erect, dark fuscous pubescence, except anteriorly the pubescence pale; parapsidal furrows distinct on posterior three-fifths of mesonotum; scutellum evenly convex, with large, dense, confluent punctures, clothed with sparse, erect, pale pubescence; dorsum, posterior face, and sides of propodeum rounded into one another, the dorsum and posterior face distinctly reticulate and clothed with long, sparse, erect, pale pubescence, the dorsum also with sparse, appressed, short, pale pubescence; inclosed space of dorsum of propodeum triangular, about two and two-fifths times as long as broad at the base; posterior face with a median, longitudinal carina extending from the apex of the inclosed space almost to the posterior margin; propleuræ micropunctate and with scattered, small punctures, clothed with short, appressed, pale pubescence, the anterior margins not well defined by a carina; median area of mesopleuræ from ventral to dorsal margins with moderate, close, more or less confluent punctures, clothed with somewhat thick, erect and appressed, pale pubescence, the anterior and posterior areas of mesopleuræ micropunctate and micropubescent; metapleuræ micropunctate and micropubescent, except a few, moderate punctures ventrally; anterior half of sides of propodeum micropunctate and micropubescent, the posterior half reticulate; tegulæ with scattered punctures and pale pubescence, except the outer, posterior fourth glabrous, impunctate, and the posterior, marginal area faintly transversely rugose.

Abdomen black, except the second abdominal segment mostly ferruginous, the median, posterior fourth of the second tergite also blackish; first five abdominal segments clothed with sparse, erect, pale pubescence, the remainder of the tergites with sparse, black pubescence, the remainder of the sternites with pale fuscous pubescence; first tergite with very sparse, shallow, small punctures becoming closer and more distinct posteriorly and laterally; second tergite with very sparse, fine punctures medially, becoming small and sparse laterally, and the anterolateral areas with moderately small, distinct, separated punctures; tergites three to six with small, sparse punctures; last tergite with moderate, close, somewhat confluent punctures, except a narrow, median, elongate area on the posterior half glabrous, impunctate; first sternite with a distinct carina on the anterior two-thirds, the carina only slightly higher posteriorly than anteriorly; second sternite with moderately large, sparse punctures; sternites three to six with moderate punctures, close and almost confluent on the third and fourth, separated and somewhat sparse on the fifth and sixth, but very sparse at the midline on all four sternites; hypopygium with moderate, sparse punctures anteriorly, small, close punctures medially, and glabrous, impunctate posteriorly.

Wings subfuscous; cell 2d $R_1 + R_2$ about one and one-third times as long as cell $R +$ 1st $R_1$, the former three times as long as broad, truncate at the apex; cell $R_5$ receiving vein $M_{3+4}$ distinctly beyond the middle; cell $R_4$ present but very indistinct, receiving vein $M_2$ two-thirds the distance from base to apex.

Legs entirely black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49350, United States National Museum, MINDANAO, Kolambugan (*Baker*).

*Paratypes.*—SAMAR, 3 males (*Baker*). MINDANAO, male, Surigao; 2 males, Iligan (*Baker*); 3 males, Kolambugan (*Baker*); male, Dapitan (*Baker*).

There is a great amount of variation in the extent of the ferruginous area of the abdomen among the paratypes. At one extreme is a specimen from Samar which has the abdomen black, except the lateral thirds of the second tergite, and the second sternite entirely, ferruginous; another from Samar has in addition to this the lateral thirds of the first tergite ferruginous; several specimens are like the type in having the second tergite entirely ferruginous except a posterior, median, transverse spot, black; other specimens have the second segment entirely ferruginous; and one specimen from Iligan has the first, second, and almost all of the third segments ferruginous. The puncturation of the body and the color of the first flagellar segments are the same in all specimens.

### TIMULLA (TROGASPIDIA) STICTICORNIS subsp. NIGRIDIA subsp. nov.

*Male.*—Entirely black, except the first flagellar segment beneath yellowish; first flagellar segment distinctly shorter than the second; front with moderately large, dense, confluent punctures as in *sticticornis;* mandibles excised beneath and with a small tooth near the base beneath; scutellum evenly convex; first five abdominal segments clothed with sparse, erect, pale pubescence, the remaining tergites with black pubescence, the remaining sternites with pale fuscous pubescence. Wings subfuscous. Length, 14 millimeters. Otherwise like the subspecies *sticticornis.*

*Holotype.*—Male, catalogue No. 49351, United States National Museum, MINDANAO, Iligan (*Baker*).

*Paratypes.*—MINDANAO, 9 males, Iligan (*Baker*); 5 males, Kolambugan (*Baker*); male, Dapitan (*Baker*); male, Zamboanga (*Baker*).

This subspecies is exactly like the subsp. *sticticornis* except that the body is entirely black and the yellow of the flagellum is restricted to the first segment. All other characters are the same as in the type subspecies. The length of the paratypes varies from 10 to 15 millimeters.

### Genus SMICROMYRME Thomson

*Key to the species.*

MALES

1. Thorax largely ferruginous, the pleural areas and propodeum in part black; abdomen steel blue to black.... *ilerda* subsp. *sparsilis* subsp. nov.
   Thorax entirely black; abdomen entirely black, entirely metallic blue, or black and ferruginous.................... 2.
2. Mandibles distinctly or deeply emarginate beneath, and with a large, prominent, broad process, or a distinct tooth at the base beneath.... 5.
   Mandibles with the ventral margin straight, not at all emarginate, and without a tooth or process beneath at the base.................... 3.
3. Wings subhyaline; all the abdominal segments clothed with sparse, pale pubescence; first segment of flagellum only one-fourth the length of the second; body unicolorous, bright metallic blue.... *caerulea* sp. nov.
   Wings subfuscous; last two abdominal segments clothed with sparse, black pubescence; first segment of flagellum one-third of the length of the second; if body unicolorous, then black with obscure metallic blue reflections .................... 4.
4. Abdomen with the second abdominal segment entirely, and the third segment in part or entirely, ferruginous.
   *viriata* subsp. *viriata* sp. et subsp. nov.
   Body unicolorous, black with obscure metallic blue reflections.
   *viriata* subsp. *nitela* subsp. nov.
5. Mandibles with a large, prominent, broad process at the base beneath; clypeus distinctly depressed below the dorsal margin of the mandibles. 6.
   Mandibles without a large, prominent, broad process beneath, at the most with a distinct tooth proximad of the excision; clypeus not depressed below the dorsal margin of the mandibles.................... 8.
6. Mandibles very broad at the apex, tridentate.................... *fluctuata* (Smith).
   Mandibles narrow at the apex, bidentate.................... 7.
7. Mandibles with a high carina on the proximal half of the dorsal surface, the small tooth within subapical; clypeus without a median, longitudinal, sharp ridge .................... *palawanensis* sp. nov.
   Mandibles without a high carina on the proximal half of the dorsal surface, the inner tooth remote from the apex; clypeus with a median, longitudinal, sharp ridge.................... *zebina* (Smith).
8. Inner margin of hind coxæ armed its full length with a sharp carina, posteriorly the coxæ squarely truncate, thus the posterior-inner angle

of coxæ sharply angulate; second abdominal tergite with moderate to large punctures .......... 9.

Posterior half of inner margin of hind coxæ not armed with a carina, the posterior margin of the coxæ not truncate, thus the posterior-inner angle of hind coxæ rounded; second abdominal tergite with very sparse, small punctures .......... 11.

9. Tegulæ with small, dense punctures; wings subfuscous; second abdominal tergite with moderately large, distinct, separated punctures.. 10.

Tegulæ with small, well-separated, shallow punctures; wings subhyaline; second abdominal tergite with moderate, sparse punctures. *bakeri* sp. nov.

10. First two abdominal segments ferruginous. *semperi* subsp. *semperi* (Ashmead).

Abdomen entirely black.......... *semperi* subsp. *melanogastra* subsp. nov.

11. First two or first three abdominal segments more or less ferruginous. *lavinia* subsp. *lavinia* sp. et subsp. nov.

Body unicolorous, entirely black.......... *lavinia* subsp. *atrata* subsp. nov.

FEMALES

1. Second abdominal tergite with a single, median, anterior spot of pale pubescence .......... 2.

Second abdominal tergite with three anterior spots of pale pubescence, one median and two lateral.......... 7.

2. Abdomen dark metallic blue; third abdominal tergite clothed entirely with black pubescence .......... *hyale* sp. nov.

Abdomen black; third abdominal tergite maculated with pale pubescence. 3.

3. Third abdominal tergite with a large, median, transverse spot of pale pubescence .......... 4.

Third abdominal tergite clothed entirely with pale, appressed pubescence. 5.

4. Scape, coxæ, trochanters and femora except the tips, ferruginous, the femoral tips, tibiæ, and tarsi blackish. *fura* subsp. *fura* sp. et subsp. nov.

Scape and legs entirely black.......... *fura* subsp. *anthracipes* subsp. nov.

5. Scutellar scale present .......... 6.

Scutellar scale absent; scape, coxæ, trochanters and femora except tips, ferruginous .......... *parva* (Brown).

6. Scape, legs, and first abdominal segment entirely ferruginous. *basalis* subsp. *basalis* (Smith).

Scape and legs black; first abdominal segment largely black. *basalis* subsp. *annularis* subsp. nov.

7. Second abdominal tergite with a narrow, apical fringe of pale pubescence; posterior fourth of pygidium glabrous, the striæ not extending to the posterior margin.......... *autonoe* sp. nov.

Second abdominal tergite entirely black pubescent except for the three anterior, pale pubescent spots; pygidium longitudinally striate throughout .......... 8.

8. Pale pubescent spots of second tergite in a transverse row; third and fourth abdominal tergites entirely pale pubescent.......... *zebina* (Smith).

Median, anterior, pale pubescent spot of second tergite distinctly anterior to the lateral spots; only the third abdominal tergite entirely pale pubescent, the fourth with pale pubescence laterally.
*semperi* subsp. *semperi* (Ashmead).

**SMICROMYRME ILERDA subsp. SPARSILIS subsp. nov.**

*Male.*—Head, ventral plate of metapleuræ, sides and posterior face of propodeum, and legs all black; remainder of thorax pale ferruginous; abdomen dark metallic blue; pronotum with large, close but distinctly separated punctures; second and third abdominal tergites each with an apical band of dense, appressed, pale pubescence. Wings fuscous. Length, 14 millimeters.

Head entirely black, the front with thick, suberect, pale fulvous pubescence; except the genæ also with thick, short, appressed, pale pubescence adjacent to the posterior eye margins; mandibles moderately excised beneath, forming a small blunt tooth beneath near the base; clypeus without an elevated median area, with a median, longitudinal, low ridge, finely punctate and clothed with appressed, pale fulvous pubescence; scape distinctly bicarinate beneath, elsewhere with small, close punctures and sparse, pale fulvous pubescence; first flagellar segment about one-third the length of the second; proximal flagellar segments more or less ferruginous beneath; antennal scrobes in part carinate above, the carina extending half the distance between the antennal tubercles and the eyes; front with moderate, close, confluent punctures merging into the longitudinally striate-punctate vertex; genæ with small, close, more or less confluent punctures; relative widths of head and thorax including the tegulæ, 4.2: 5.0.

Thorax ferruginous, except the posteroventral angle of mesopleuræ, the ventral plate of the metapleuræ, the sides and the posterior face of propodeum, all blackish; pronotum and mesonotum with moderately large, close but distinct punctures, clothed with sparse, erect, fulvous pubescence; parapsidal furrows present on the posterior two-thirds of mesonotum, but shallow; scutellum evenly convex, with moderately large, dense, confluent punctures and sparse, erect, fulvous pubescence; dorsum, posterior face and sides of propodeum all rounded into one another, the dorsum and posterior face distinctly reticulate and clothed with sparse, erect, pale fulvous pubescence, the dorsum also with somewhat thick, short, obscure, pale pubescence; median inclosed area of dorsum of propodeum subtriangular, the sides sinuate, about two and one-half times as long as broad at the base; posterior face of propodeum with a median, longitudinal, sinuate carina extending from the apex of the median inclosed area to the posterior margin; propleuræ defined anteriorly by a distinct carina, micropunctate and micropubescent, and with a very few, small, scattered punctures; mesopleuræ with moderately large, close, more or less confluent punctures becoming sparse on the anterior area, the latter micropunctate and micropubescent, the mesopleuræ elsewhere with sparse, erect, and short, sparse, appressed, pale pubescence; metapleuræ micropunctate and micropubescent, except for moderately large, close, shallow punctures ventrally; sides of propodeum reticulate, the reticulations smaller than on the posterior face; tegulæ large, extending one-third their length behind the posterior margin of mesonotum, entirely ferruginous, with sparse, small punctures, and sparse, recumbent, fulvous pubescence throughout.

Abdomen dark metallic blue, the first four segments with sparse, erect, pale pubescence, the second and third also with broad, apical bands of dense, appressed and sparse, erect, pale pubescence; remaining abdominal segments with sparse, erect, black pubescence; first tergite with sparse, moderate punctures becoming close laterally, and smaller but still sparse posteriorly; second tergite with moderate, distinct punctures, well separated medially, becoming close laterally; tergites three to six with small, sparse punctures, those on the anterior half (that part telescoping into the adjacent anterior segment) with the punctures more regular and the pubescence very short, the posterior half with the pubescence long; last tergite with small, close punctures throughout, except a weakly defined subtriangular area adjoining the posterior margin, glabrous, impunctate; first sternite with a distinct, median, longitudinal carina, the latter distinctly higher posteriorly than anteriorly; second sternite with moderately large, close, slightly confluent punctures throughout; sternites three to six with moderately small punctures, becoming close at the posterior margin of each; hypopygium with small, distinct, separated punctures.

Wings fuscous with violet reflections; cells 2d $R_1 + R_2$ and $R +$ 1st $R_1$ equal in length, the former acute at the apex; cell $R_5$ narrow, elongate, receiving vein $M_{3+4}$ slightly before the middle; cell $R_4$ present but less distinct than $R_5$ and receiving vein $M_2$ two-thirds the distance from base to apex.

Legs black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49352, United States National Museum, MINDANAO, Dapitan (*Baker*).

*Paratypes.*—MINDANAO, 5 males, Butuan (*Baker*); male, Tangkulan, Bukidnon (*Baker*); 2 males, Iligan (*Baker*); male, Kolambugan (*Baker*); 9 males, Dapitan (*Baker*); male, Davao (*Baker*).

These specimens have been compared with the holotype of *ilerda* Cameron. They differ from the latter only in having the punctures of the pronotum more separated and distinct and in having the punctures of the second tergite larger, closer, and stronger. This species is the only one of this genus recorded from the Philippine Islands having a ferruginous thorax and metallic blue abdomen.

### SMICROMYRME HYALE sp. nov.

*Female.*—Head and flagellum black; antennal tubercles, scape, thorax, and legs ferruginous; abdomen dark steel blue; thorax without a scutellar scale, slightly narrower posteriorly than anteriorly; second tergite with a median, elongate spot adjoining the anterior margin, and a broad, apical band of pale, appressed pubescence; tergites three to five black pubescent; pygidial area distinct, glabrous, unsculptured. Length, 8 millimeters.

Head black, except the antennal tubercles and scape, ferruginous; flagellum beneath and mandibles medially tinged with ferruginous; mandibles edentate at the tip and with a small tooth within near the apex; clypeus elevated, forming a transverse, arcuate, elevated margin posteriorly, the area anterior to the elevated margin transversely concave and glabrous, posterior to the elevated margin densely punctate; scape with small, close punctures and sparse, pale pubescence; first segment of flagellum slightly but distinctly longer than the second; antennal scrobes distinctly carinate above; front, vertex, and genæ with moderate, dense, confluent punctures, clothed with very sparse, recumbent, pale pubescence, the front and vertex also with scattered, erect, blackish hairs; front with a median, longitudinal, obscure carina; relative widths of head and thorax, 3.0: 2.6.

Thorax entirely ferruginous, the dorsum clothed with sparse, recumbent, fulvous pubescence and scattered, erect, dark fulvous hairs; lateral margins of dorsum of thorax somewhat crenulate, straight, slightly converging posteriorly, relative widths of the thorax at the pronotal region and propodeal region, 2.6: 2.3; humeral angles angulate; dorsum with moderate, dense, confluent punctures, becoming reticulate on the dorsum of propodeum; scutellar scale absent; posterior face of propodeum incompletely reticulate anteriorly, becoming glabrous, sparsely punctate on the posterior half; propleuræ defined anteriorly by a carina; all the pleural areas including the sides of propodeum micropunctate and micropubescent, the propleuræ also with a few, scattered, small, shallow punctures, and the mesopleuræ with moderate, close, shallow punctures posteroventrally.

Abdomen dark metallic blue, except the first sternite tinged with ferruginous; first tergite with small, sparse punctures, except the narrow, apical margin glabrous, impunctate, clothed with sparse, erect, pale pubescence; second tergite with small, dense, confluent punctures, the latter becoming slightly larger and sparse laterally, clothed with sparse, short, recumbent, and scattered, erect, black pubescence, the lateral areas with only scattered, erect, pale pubescence, and also an elongate, median spot adjoining the anterior margin, as well as a broad, apical band of dense, appressed, pale pubescence; tergites three to five with small, close punctures and clothed with sparse, short, recumbent and scattered, erect, black pubescence, except the third tergite anteriorly with scattered, recumbent, pale hairs, the fifth tergite posterolaterally with erect, pale hairs, and each of the tergites at the lateral margins with a few pale hairs; last tergite with small, close punctures, and sparse, erect, pale pubescence laterally, the pygidial area well defined, glabrous, unsculptured; first sternite with a high, sharp, straight carina on the anterior four-fifths, not at all higher posteriorly than anteriorly; second tergite with moderate, close, distinct punctures throughout, clothed with very sparse, pale pubescence, and with a thin, apical fringe of pale hairs; sternites three to five finely, transversely striate anteriorly and with small, separated, distinct punctures posteriorly, each with a thin, apical fringe of pale hairs; hypopygium striate anteriorly and punctate posteriorly like sternites three to five, the punctate area with sparse, erect, pale pubescence.

Legs ferruginous, except the basal third of the tibiæ and all of the tarsi infuscated, sparsely clothed with pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49353, United States National Museum, MINDANAO, Iligan (*Baker*).

*Paratype.*—MINDANAO, female, Kolambugan (*Baker*).

Related to *calliope* Smith from Borneo but differs in having the third tergite entirely black pubescent, and in having the scape and legs ferruginous. The paratype differs from the holotype in being smaller (length, 6 millimeters) and in having the head a little less coarsely punctured. This may be the female of *ilerda* subsp. *sparsilis*.

**SMICROMYRME VIRIATA subsp. VIRIATA sp. et subsp. nov.**

*Male.*—Black, except the second abdominal segment entirely and the third segment in part, ferruginous; mandibles not at all excised beneath and without a tooth beneath near the base; anterior margin of clypeus broadly and very shallowly emarginate; first segment of flagellum about one-third the length of the second; pronotum very sparsely pale pubescent; first five abdominal segments with sparse, pale pubescence; wings subfuscous. Length, 12 millimeters.

Head entirely black, clothed with pale pubescence, scattered and erect on the vertex, thicker and both erect and appressed on the front and genæ; mandibles not at all excised beneath nor with a tooth beneath near the base, edentate at the tip and with a small tooth within near the apex; clypeus almost flat, slightly elevated along the median, longitudinal line, the anterior margin medially broadly and shallowly emarginate, with small, close punctures and sparse, thick, pale pubescence; scape distinctly bicarinate beneath, with small, close punctures elsewhere, and with sparse, pale pubescence; first segment of flagellum about one-third the length of the second; antennal scrobes with a carina above extending posteriorly from the antennal tubercles and about half way to the eye margins; front with moderately small, close, confluent punctures anteriorly merging into the longitudinally striate-punctate area of the front and vertex, the front also with a median, longitudinal furrow extending anteriorly from the median ocellus; genæ with small, close, shallow punctures; relative widths of head and thorax including the tegulæ, 3.8: 4.2.

Thorax entirely black; pronotum with moderately large, close, distinct punctures, clothed with very sparse, pale pubescence, except the extreme narrow, posterior margin with a line of dense, appressed pubescence; mesonotum with moderately large, distinct punctures, clothed with sparse, erect, black pubescence; parapsidal furrows shallow but present the entire length of mesonotum; scutellum comparatively flat, with moderate, dense, confluent punctures and sparse, erect, pale pubescence; dorsum, posterior face and sides of propodeum rounded into one another, the dorsum and posterior face distinctly reticulated and with very sparse, erect, pale pubescence, the dorsum also with short, recumbent, somewhat thick, obscure, pale pubescence; median area of dorsum of propodeum elongate, the sides straight, almost parallel, about two and one-half times as long as broad, acute at the tip; posterior face of propodeum without a median, longitudinal carina; propleuræ defined anteriorly by a carina, micropunctate and with moderate, shallow, close, obscure punctures, clothed with sparse, pale pubescence; mesopleuræ with moderate, distinct punctures medially becoming sparse and scattered anteriorly and posteriorly, the anterior and posterior areas also micropunctate and micropubescent, the median area clothed with thick, appressed, and sparse, erect, pale pubescence; metapleuræ micropunctate and micropubescent, except ventrally with moderate, sparse punctures; sides of propodeum shallowly reticulate; tegulæ large, extending behind the posterior margin of mesonotum a little less than one-third their length, with small, sparse punctures, and sparse, recumbent pubescence, black on the disk, pale at the margins.

Abdomen black with very obscure, metallic blue reflections, except the second segment entirely and the third segment in part, ferruginous; first five abdominal segments with sparse, pale pubescence, the terminal segments with sparse, black pubescence; first tergite with moderate, sparse punctures, becoming small and close at the lateral and posterior margins; second tergite with moderately small, sparse punctures throughout; tergites three to six with small, sparse punctures; last tergite with moderate punctures, close and distinct laterally, sparse, shallow, and obscure medially; first sternite with a median, longitudinal carina on the anterior two-thirds, only slightly higher posteriorly than anteriorly; second sternite with moderate, distinct, separated punctures throughout; sternites three to six with small, sparse punctures becoming closer towards the posterior margin; hypopygium with moderate, close punctures.

Wings subfuscous with faint violet reflections; cell 2d $R_1 + R_2$ slightly but distinctly shorter than cell R + 1st $R_1$, the former acute at the tip; cell $R_5$ long and narrow, receiving vein $M_{3+4}$ slightly beyond the middle; cell $R_4$ present but less distinct than $R_5$, receiving vein $M_2$ about three-fifths the distance from base to apex.

Legs entirely black, clothed with sparse, pale pubescence; calcaria pale.

*Holotype*.—Male, catalogue No. 49354, United States National Museum, MINDANAO, Iligan (*Baker*).

*Paratypes.*—LUZON, male, Los Baños, August, 1916 (*F. X. Williams*); 3 males, Los Baños, 1917 (*F. X. Williams*); 3 males, Los Baños (*Baker*); male, Manila, February, 1919 (*R. C. McGregor*); male, Manila (*Robert Brown*); male, Mount Maquiling (*G. Villegas*); 4 males, Mount Maquiling (*Baker*); 3 males, Baguio, Benguet (*Baker*). SAMAR, 3 males (*Baker*). SIBUYAN, 4 males (*Baker*). PANAY, male, northwestern part (*Baker*). BILIRAN, male (*Baker*). MINDANAO, 2 males, Surigao; male, Butuan (*Baker*); 13 males, Tangkulan, Bukidnon (*Baker*); 8 males, Iligan (*Baker*); 3 males, Kolambugan (*Baker*); 3 males, Dapitan (*Baker*); 4 males, Davao (*Baker*); male, Zamboanga (*Baker*).

The paratypes range in length from 5 to 13 millimeters. The second abdominal tergite is entirely ferruginous in all the specimens examined; the third segment has the sternite entirely ferruginous, and in most specimens the anterior half of the tergite is ferruginous, the posterior half black; a few specimens have the third tergite entirely ferruginous, and one from Baguio, Benguet, also has the fourth segment entirely ferruginous; in most specimens the black areas of the abdomen have obscure, metallic blue reflections, and in a few the metallic blue reflections are obvious not only on the abdomen but also on the thorax. The smaller specimens have the pubescence of the tegulæ entirely pale, the larger ones have the pubescence of this area as described for the holotype. None of these variations are correlated with the geographic distribution of the species but occur in specimens taken in the same locality. *Smicromyrme viriata* is related to *annexa* Cameron from Borneo but the latter species has the mandibles slightly excised beneath, has the first and second abdominal segments ferruginous, the tegulæ brownish, and the antennal tubercles ferruginous. *Smicromyrme fura* may be the female of *viriata*.

**SMICROMYRME VIRIATA subsp. NITELA subsp. nov.**

1895. *Mutilla nigra* BINGHAM, Ann. & Mag. Nat. Hist. VI 16: 440, male (nec Smith).

*Male.*—Entirely black with obscure metallic blue reflections; mandibles not at all excised beneath and without a tooth beneath near the base; clypeus with the anterior margin broadly, shallowly emarginate medially; first segment of flagellum one-third the length of the second; wings subfuscous. Exactly like the subsp. *viriata* except the color, and larger average size. Length, 13.5 millimeters.

*Holotype.*—Male, catalogue No. 49355, United States National Museum, LUZON, Mount Maquiling (*Baker*).

*Paratypes.*—LUZON, male, Los Baños (*Baker*); 4 males, Mount Maquiling (*Baker*); male, Lamao, March–June, 1911 (*C. V. Piper*); male, Cape Engaño (*Whitehead*); male, Malinao, Tayabas (*Baker*); male, Montalban. SAMAR, male, Catbalogan, 8 males (*Baker*). NEGROS, male, Cuernos Mountains (*Baker*). MINDANAO, male, Surigao (*Baker*); male, Iligan (*Baker*).

The paratypes vary in length from 8.5 to 14 millimeters. Some of the specimens have not only the pubescence of the tegulæ entirely pale but also that of the mesonotum is pale. This variation occurs in the larger specimens as well as in the smaller ones. There is also a variation in the intensity of the metallic blue reflections of the body, some specimens being almost without such reflections. The specimen listed above from Cape Engaño (*Whitehead*) is the specimen recorded by Bingham as *Mutilla nigra*. An examination of this specimen revealed that it was a specimen of this subspecies. Smith's *nigra* is not a *Smicromyrme* but belongs to the genus *Timulla* subgenus *Trogaspidia*.

### SMICROMYRME FURA subsp. FURA sp. et subsp. nov.

*Female.*—Head, abdomen, tips of middle and hind femora, middle and hind tibiæ, and all the tarsi, black; antennal tubercles, scape, thorax, coxæ, trochanters, front femora and tibiæ, and middle and hind femora except the tips, all ferruginous; scutellar scale present and distinct; second tergite with a median, elongate-ovate, anterior spot and an apical band of pale pubescence, the anterior spot in a shallow, longitudinal depression; third tergite with a large, median, transverse spot of pale pubescence; pygidial area longitudinally striate on the anterior five-sixths, the posterior sixth glabrous. Length, 6 millimeters.

Head black, except the mandibles medially, the antennal tubercles and scape, ferruginous; flagellum slightly tinged with ferruginous beneath; mandibles slender, edentate at the tips and with a small tooth within near the apex; clypeus elevated along the median, transverse line into a sharp, sinuate, transverse ridge, the clypeal area anterior to the ridge glabrous, impunctate, posterior to the ridge finely, closely punctate and with a small, median tubercle, the ridge itself with a thin fringe of pale hairs; scape with small, sparse punctures and sparse, pale pubescence; first segment of flagellum about one and one-fourth times longer than the second; antennal scrobes carinate above;

front, vertex, and genæ with moderate, dense, confluent punctures, clothed with sparse, recumbent, obscure, pale pubescence, and scattered, erect, dark hairs, the posterior region of the vertex with an obscure, transverse band of appressed, pale pubescence; posterior margin of genæ defined by an obscure carina; relative widths of head and thorax, 2.55 : 2.0.

Thorax entirely ferruginous, the dorsum clothed with sparse, short, recumbent, fulvous pubescence, and sparse, erect, dark fulvous hairs, the posterior face of propodeum with sparse, erect, pale pubescence; humeral angles angulate; thorax broadest at the anterior spiracles; mesonotal area slightly narrower than the pronotal and propodeal areas; lateral margins of dorsum of thorax somewhat crenulate; scutellar scale present and distinct; dorsum of thorax with moderate, dense, confluent punctures merging into reticulate on the dorsum of propodeum, the reticulation extending onto the anterior area of the posterior face of propodeum, the remainder of the latter sparsely punctate; lateral margins of dorsum of propodeum faintly denticulate; propleuræ defined anteriorly by a carina; posteroventral area of mesopleuræ with a few, moderate, shallow punctures; remainder of pleural areas including sides of propodeum, micropunctate and micropubescent.

Abdomen entirely black; first tergite with small, sparse punctures, the latter becoming close at the posterior margin, and clothed with sparse, erect, pale pubescence; second tergite with small, dense, confluent punctures, except the lateral areas with moderate, distinct, close punctures; median area of second tergite with short, appressed, black pubescence, and sparse, erect, dark hairs, the lateral areas with sparse, erect, pale hairs, except an anterior, median, elongate ovate spot, and an apical band of dense, appressed, pale pubescence; anterior pale spot of second tergite in a shallow, longitudinal depression; tergites three to five with very small, close punctures, clothed with sparse, erect, black pubescence, except the third tergite with a large, median, transverse spot of dense, appressed, pale pubescence, and each of the tergites with a few, erect, pale hairs at their lateral margins; last tergite with small, close punctures and sparse, erect, pale pubescence laterally; pygidial area distinct, the anterior five-sixths longitudinally striate, the posterior sixth glabrous, impunctate; first sternite with a high, sharp, median, longitudinal carina on the anterior two-thirds; second tergite with moderate, distinct, separated punctures throughout, clothed with sparse, erect, pale pubescence, and a thin, apical fringe of pale hairs; sternites three to five finely, transversely striate anteriorly, with small punctures posteriorly, becoming close at the posterior margin, and each with a thin, apical fringe of pale hairs; hypopygium with small, close punctures and sparse, pale pubescence.

Coxæ, trochanters, front femora and tibiæ, and middle and hind femora except the tips, ferruginous; remainder of legs blackish; clothed throughout with sparse, pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49356, United States National Museum, MINDANAO, Tangkulan, Bukidnon (*Baker*).

*Paratypes.*—LUZON, 2 females, Mount Maquiling (*Baker*); female, Paete. SAMAR, female (*Baker*). SIBUYAN, 3 females (*Baker*). PANAY, female, northwestern part (*Baker*). MINDANAO, 2 females, Surigao; 4 females, Tangkulan, Bukidnon (*Baker*); 2 females, Iligan (*Baker*); female, Kolambugan (*Baker*); female, Davao (*Baker*); female, Zamboanga (*Baker*). BASILAN, 2 females (*Baker*).

The specimens from the southern islands exhibit a tendency for the pale spot on the third tergite to become smaller, and the middle and hind tibiæ to become ferruginous. The female from Zamboanga has the tibiæ almost entirely ferruginous. The paratypes vary in length from 4.5 to 9 millimeters. This may be the female sex of subsp. *viriata*.

### SMICROMYRME FURA subsp. ANTHRACIPES subsp. nov.

*Female.*—Head, abdomen, and legs black; thorax entirely ferruginous; antennal tubercles dull ferruginous; scutellar scale present and distinct; second tergite with a median, elongate-ovate, anterior spot and an apical band of pale pubescence, the anterior spot in a shallow, longitudinal depression; third tergite with a large, median, transverse spot of pale pubescence; pygidial area longitudinally striate, except the apical sixth granulate. Length, 10 millimeters.

*Holotype.*—Female, catalogue No. 49357, United States National Museum, LUZON, Baguio, Benguet (*Baker*).

*Paratype.*—LUZON, female, Mount Arayat, Pampanga, March 15, 1923 (*R. C. McGregor*).

Exactly like subsp. *fura* except the scape and legs entirely black, the pygidium granulate apically, and the size larger.

**SMICROMYRME CAERULEA** sp. nov.

*Male.*—Body unicolorous, bright metallic blue, clothed throughout with pale pubescence; mandibles not excised beneath and without a tooth near the base beneath; first segment of flagellum only one-fourth the length of the second; mesonotum with moderate, close punctures throughout; anterior half of second tergite sparsely punctate, the posterior half with moderate, distinct punctures, less than their own diameter apart; wings subhyaline. Length, 13 millimeters.

Head bright metallic blue, the antennæ black; mandibles slender, not excised beneath, without a tooth beneath near the base, edentate at the tips and with a small tooth within near the apex; clypeus almost flat, with fine, close punctures and moderately thick, appressed, pale pubescence, the anterior margin not emarginate; scape bicarinate beneath, with small, sparse punctures and sparse, pale pubescence; first segment of flagellum about one-fourth the length of the second; antennal scrobes above with a carina extending posteriorly from the antennal tubercles and only reaching half the distance to the margin of the eyes; front and vertex longitudinally striate-punctate throughout, the front with a median, longitudinal furrow extending anteriorly from the median ocellus; genæ with moderately small, close punctures; front, vertex, and genæ with sparse, pale pubescence, except the front medially and the genæ adjacent to the eye margins with the pubescence thick; relative widths of head and thorax including the tegulæ, 3.6 : 4.5.

Thorax bright metallic blue, clothed throughout with sparse, pale pubescence, except the posterior margin of the pronotum with a line of thick pubescence, and the mesopleuræ with the pubescence thick; pronotum with moderately large, close, slightly confluent punctures; mesonotum with moderate, close punctures; parapsidal furrows present but shallow and indistinct; scutellum moderately convex, with moderate, close, somewhat confluent punctures; dorsum, posterior face and sides of propodeum rounded into one another; dorsum and posterior face of propodeum reticulate; median area of dorsum of propodeum elongate, about two and one-half times as long as broad, the sides sinuate; posterior face of propodeum with a median, longitudinal, slightly sinuate carina extending from the apex of the median area to the posterior margin; propleuræ defined anteriorly by a distinct carina, with moderate, shallow, close punctures; mesopleuræ with moderate, distinct punctures medially, becoming sparse and shallow anteriorly and posteriorly; metapleuræ micropunctate and micropubescent, except ventrally with moderate, close punctures; sides of propodeum reticulate; tegulæ moderate in size, extending behind the posterior margin of mesonotum about one-fifth their length, punctate and pubescent throughout, the punctures smaller and closer towards the outer margin.

Abdomen bright metallic violet-blue, clothed throughout with sparse, pale pubescence; first tergite with scattered, moderate, shallow punctures, except at the posterior margin with moderate, close, distinct punctures; second tergite with moderate punctures, sparse and shallow on the anterior half, closer and more distinct on the posterior half; tergites three to six with moderately small, separated, shallow punctures; last tergite with small, distinct punctures, except an apical, median, subtriangular area glabrous, impunctate; first sternite with a median, longitudinal, high carina on the anterior two-thirds, not higher posteriorly than anteriorly; second sternite with moderate, distinct, separated punctures becoming sparse at the median longitudinal line; sternites three to six with moderately small punctures, becoming close at the posterior margin of each; hypopygium with moderately small, distinct punctures.

Wings subhyaline; cells 2d $R_1 + R_2$ and $R + 1\text{st } R_1$ approximately equal in length, the former acute at the apex; cell $R_5$ long and narrow, receiving vein $M_{3+4}$ slightly before the middle; cell $R_4$ present but less distinct than $R_5$, receiving vein $M_2$ slightly beyond the middle.

Legs metallic blue, sparsely clothed with pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49358, United States National Museum, SAMAR (*Baker*).

Related to *viriata* but differs in the length of the first antennal segment, the form of the clypeus, puncturation of body, as well as color of the body and the pubescence.

**SMICROMYRME BASALIS subsp. BASALIS (Smith).**

1879. *Mutilla basalis* SMITH, Descr. New Species Hymen. 200, female.
1897. *Mutilla basalis* DALLE TORRE, Cat. Hymen. 8: 15, female.
1903. *Mutilla basalis* ANDRÉ, Gen. Ins. 1, fasc. 11: 38, female.

*Holotype.*—Female, Sarawak, Borneo, in British Museum of Natural History.

*Specimens examined.*—MINDANAO, female, Surigao; 4 females, Iligan (*Baker*).

Smith's type of this species has been examined and Borneo specimens compared with the type are before me. The Philippine specimens placed here are indistinguishable from the Borneo specimens. The species resembles *fura* in some respects but differs in that the anterior pale pubescent spot of the second tergite is not in a depression, and the third tergite has a broad, complete band of pale pubescence.

### SMICROMYRME BASALIS subsp. ANNULARIS subsp. nov.

*Female.*—Head, abdomen, and legs black; thorax entirely ferruginous; scutellar scale present; second tergite with an anterior, median, ovate spot, and a narrow, apical band, of dense, appressed, pale pubescence, the anterior spot not situated in a depression; third tergite with a broad, complete band of dense, appressed, pale pubescence; pygidium longitudinally striate, the striæ not reaching the apical margin. Length, 6.5 millimeters.

*Holotype.*—Female, catalogue No. 49359, United States National Museum, LUZON, Baguio, Benguet (*Baker*).

*Paratype.*—LUZON, 3 females, Mount Maquiling (*Baker*).

Exactly like the subsp. *basalis* Smith, except that the scape, legs, and first abdominal segment are entirely black.

### SMICROMYRME PARVA (Brown).

1906. *Mutilla parva* BROWN, Philip. Journ. Sci. 1: 685, female.

*Type.*—Female, Manila. Location of type unknown.

*Specimens examined.*—LUZON, female, Los Baños, August, 1916 (*F. X. Williams*); female, Los Baños (*Baker*); female, Manila, July, 1907 (*W. Schultze*); female, Mount Maquiling (*Baker*). MINDANAO, female, Surigao (*Baker*).

I have not been able to examine Brown's type of this species. The specimen listed above from Manila has been determined as *parva* by Mr. C. S. Banks. All of the above specimens agree with the original description with the exception of the last sentence of the latter. I have never seen any female mutillid with the "third and fourth ventral segments strongly longitudinally carinate." The original type was so small (4.5 millimeters in length) that I am doubtful if this statement can be taken literally. In fact, I am convinced that the above specimens are representatives of Brown's species *parva*, since they agree with all other points in the original description, and are the only ones among the large number of specimens from the Philippine Islands which I have studied that do satisfy the requirements of the original description.

The specimens examined vary from 4.5 to 6.5 millimeters in length. The pygidium is glabrous, almost unsculptured, but very feebly, longitudinally striate. The thorax lacks a scutellar scale.

**SMICROMYRME FLUCTUATA (Smith).**

1865. *Mutilla fluctuata* SMITH, Journ. Proc. Linnean Soc. London 8: 80, male.
1897. *Mutilla fluctuata* DALLE TORRE, Cat. Hymen. 8: 41, male.
1903. ............. *fluctuata* ANDRÉ, Gen. Ins. 1, fasc. 11: 70, male.

*Holotype.*—Male, Morty Island, in Saunders's collection, Oxford University, England.

*Specimens examined.*—SAMAR, male (*Baker*). NEGROS, male, Cuernos Mountains (*Baker*). MINDANAO, male, Iligan (*Baker*); male, Dapitan (*Baker*); male, Davao (*Baker*).

These specimens have been compared with Smith's type and found to be identical with it. The species is characterized by much more robust mandibles than those of previous males; mandibles tridentate at the apex, deeply and broadly excised beneath forming a broad process between the excision and the base of the mandibles; clypeus depressed below the margin of the mandibles; first segment of flagellum about one-half the length of the second; tegulæ glabrous, impunctate on the outer, posterior fourth.

**SMICROMYRME ZEBINA (Smith).**

1860. *Mutilla zebina* SMITH, Journ. Proc. Linnean Soc. London, Zool. suppl. 5: 115, female.
1897. *Mutilla zebina* DALLE TORRE, Cat. Hymen. 8: 99, female.
1903. *Mutilla zebina* ANDRÉ, Gen. Ins. 1, fasc. 11: 41, female.

*Holotype.*—Female, Bachian, in Saunders's collection, Oxford University, England.

The description of the male, heretofore unpublished, is as follows:

*Male.*—Entirely black, clothed with sparse, pale pubescence, except the front, pronotum and mesopleuræ with thick, appressed, pale pubescence; mandibles robust, bidentate at the apex, the inner tooth somewhat remote from the apex, deeply excised beneath forming a prominent blunt tooth beneath near the base; clypeus only very slightly depressed below the dorsal margin of the mandibles, with a distinct, median, longitudinal sharp ridge; first and second abdominal segments with a thick, apical fringe of pale pubescence; wings subhyaline. Length, 8.5 millimeters.

Head entirely black, clothed with sparse, pale pubescence, except the clypeus and front with thick, appressed, pale pubescence; mandibles and clypeus as described above, except the median ridge of clypeus abruptly higher posteriorly between the antennal tubercles; scape distinctly bicarinate beneath, with small, close punctures and sparse, pale pubescence; first segment of flagellum about half the length of the second; front with small, dense, confluent punctures merging into the striate-punctate vertex, the front also with a median, longitudinal furrow extending anteriorly from the median ocellus; genæ with very small, close punctures, the interspaces micropunctate; relative widths of head and thorax including the tegulæ, 3.0 : 3.4.

Thorax entirely black, clothed with sparse, erect, pale pubescence, except the pronotum and mesopleuræ with thick, appressed, pale pubescence; pronotum with moderately small, sparse punctures interspersed with fine, close punctures; mesonotum with moderate, close, somewhat confluent punctures; parapsidal furrows distinct; scutellum with moderately small, dense, confluent punctures; dorsum, posterior face and sides of propodeum rounded into one another, moderately reticulate; median, inclosed area of dorsum of propodeum subtriangular, the apex rounded, about twice as long as broad at the base; propleuræ defined anteriorly by a distinct carina, finely, longitudinally striate; mesopleuræ with small, dense, confluent punctures medially, the latter becoming sparse anteriorly and posteriorly; metapleuræ glabrous, micropunctate and micropubescent, except a few, moderate, shallow punctures ventrally; sides of propodeum reticulate, the reticulation becoming obsolete towards the anterior margin; tegulæ with a small, median area glabrous, impunctate, otherwise sparsely punctured and pale pubescent, the outer and posterior margins translucent.

Abdomen entirely black, clothed with sparse, erect, pale pubescence, except the posterior half of the sixth segment and all of the second segment black pubescent, and the first and second segments each with a thick, apical fringe of pale pubescence; first tergite with moderately large, close punctures; second tergite with moderate, sparse punctures, closer laterally than medially; tergites three to six with small, sparse punctures; last tergite with moderately small, dense, confluent punctures laterally, becoming sparse at the longitudinal midline; first sternite with a low, median, longitudinal carina on the anterior two-thirds; second sternite with moderate, distinct, separated punctures; sternites three to six with small punctures becoming close at the posterior margin; hypopygium with small, close distinct punctures.

Wings subhyaline; cell R + 1st $R_1$ distinctly longer than 2d $R_1 + R_2$, the latter acute at the apex; cell $R_5$ narrow, elongate, receiving vein $M_{3+4}$ about two-fifths the distance from base to apex; cell $R_4$ much less distinct than $R_5$, receiving vein $M_2$ slightly beyond the middle.

Legs entirely black, sparsely clothed with pale pubescence; calcaria pale.

*Allotype.*—LUZON, male, Los Baños, 1916 (*F. X. Williams*), mounted on the same pin with a female, and presumably taken in coitu, in collection of University of Minnesota. Females conspecific with this specimen have been compared with Smith's type of *zebina* and found to be identical with it.

*Specimens examined.*—LUZON, female, Los Baños, June, 1916 (*F. X. Williams*); female, Los Baños, August, 1916 (*F. X. Williams*); female, Limay, Bataan, October, 1913 (*W. Schultze*); female, Manila, January 16, 1906 (*C. S. Banks*); female, Montalban Gorge, Rizal, March, 1906 (*C. S. Banks*); female, Olongapo, Zambales, June 3, 1907 (*C. S. Banks*); female (*C. S. Banks*). CEBU, female, 1917 (*F. X. Williams*). MINDANAO, female, Surigao; 2 females, Dapitan (*Baker*); female, Davao (*Baker*).

The female may be recognized by the third and fourth tergites being entirely pale pubescent except the fourth subinterrupted medially, the second tergite without a pale, apical band or fringe, and the three pale pubescent spots of the second tergite arranged in a transverse straight line; the pygidium is longitudinally striate. The Luzon specimens vary with respect to the pale pubescence of the fourth tergite. The specimen taken with the allotype has the pubescence of the fourth tergite distinctly interrupted medially, while the remaining specimens have the pale band complete; the specimens from Cebu and Mindanao have this same band distinctly interrupted.

The male is related to *fluctuata*, from which it differs by the bidentate mandibles and the less-depressed clypeus, and to *palawanensis*, from which it differs by the form of the mandibles and the ridged clypeus.

### SMICROMYRME PALAWANENSIS sp. nov.

*Male.*—Entirely black, clothed with pale pubescence, except the last two abdominal segments clothed with black pubescence;

mandibles robust, the proximal half of the dorsal surface with a high carina, deeply excised beneath forming a large, blunt tooth beneath near the base, bidentate at the apex, the inner tooth subapical; clypeus flat, without a median, longitudinal ridge; first segment of flagellum about one-half the length of the second; front, pronotum, and mesopleuræ with thick, appressed, pale pubescence; first and second abdominal segments with a thick, apical fringe of pale pubescence; wings subhyaline. Length, 10 millimeters.

Head entirely black, clothed with sparse, pale pubescence, except the clypeus and front with thick, appressed, pale pubescence; mandibles as described above; clypeus noticeably depressed below the dorsal surface of the mandibles, not emarginate medially at the anterior margin and without a median longitudinal ridge; scape distinctly bicarinate beneath, with small, close punctures and sparse, pale pubescence; first flagellar segment as above; antennal scrobes not carinate above, with only a small tubercle midway between the antennal tubercles and the eye margins; front with moderate, dense, confluent punctures merging into the longitudinally striate-punctate vertex, and with a median furrow extending anteriorly from the median ocellus; genæ with small, close, distinct punctures; relative widths of head and thorax including the tegulæ, 3.6 : 3.9.

Thorax entirely black, clothed with sparse, pale pubescence, except the pronotum and mesopleuræ with thick, appressed, pale pubescence, and the mesonotum with the pubescence slightly darker than elsewhere; pronotum with sparse, moderate punctures interpersed with fine, close punctures; mesonotum with moderate close punctures, slightly confluent; parapsidal furrows distinct; scutellum with moderate, very close, confluent punctures; dorsum, posterior face, and sides of propodeum rounded into one another, the dorsum and posterior face moderately reticulate; median, inclosed space on dorsum of propodeum subtriangular, the apex somewhat rounded, slightly less than twice as long as broad at the base; propleuræ with the anterior margin defined by a distinct carina, longitudinally, finely striate; mesopleuræ with moderate, dense, confluent punctures medially becoming separated and sparse anteriorly and posteriorly; metapleuræ micropuntate and micropubescent, with a few moderate, shallow, scattered punctures ventrally; sides of propodeum distinctly reticulate posteriorly, the reticulations becoming obsolete anteriorly; tegulæ glabrous, impunctate, except the anterior and inner margins, and the posterior half, punctate and pale pubescent, the outer and posterior halves also translucent.

Abdomen entirely black, the first five segments, as well as the anterior and lateral areas of the sixth, clothed with sparse, pale pubescence, the first and second segments also with a thick, apical fringe of pale pubescence; remainder of sixth segment and the last segment, with black pubescence; first tergite with moderate, sparse punctures medially, the latter becoming smaller and close posteriorly and laterally; second tergite with moderate, distinct, separated punctures throughout, the punctures somewhat closer on the anterolateral areas; tergites three to six with moderately small, sparse punctures; last tergite with moderately small, close, confluent punctures becoming sparse medially, thus an obscure, narrow, median, longitudinal area almost impunctate; first sternite with a low, median, longitudinal carina on the anterior two-thirds, the posterior terminus of the carina slightly elevated; second sternite with moderate, distinct, separated punctures; sternites three to six with small, close punctures posteriorly; hypopygium with small, distinct, separated punctures.

Wings subhyaline; cell R + 1st $R_1$ distinctly longer than 2d $R_1 + R_2$; cell $R_5$ narrow, elongate, receiving vein $M_{3+4}$ distinctly before the middle; cell $R_4$ present but much less distinct than $R_5$ and receiving vein $M_2$ slightly beyond the middle.

Legs entirely black, sparsely clothed with pale pubescence; calcaria pale.

*Holotype.*—Male, catalogue No. 49360, United States National Museum, PALAWAN, Puerto Princesa (*Baker*).

*Paratype.*—PALAWAN, male, Puerto Princesa (*Baker*).

Related to *fluctuata* and *zebina.* Differs from the former in having bidentate mandibles and in lacking a clypeal median ridge, as well as minor differences in the sculpture of the body. It differs from *zebina* in having the prominent carina on the dorsal surface of the mandibles, the inner tooth of the mandibles much nearer the apex, the clypeus more deeply depressed beneath the margin of the mandibles, and in lacking the clypeal median ridge.

### SMICROMYRME AUTONOE sp. nov.

*Female.*—Head, abdomen, and legs black, thorax ferruginous; second abdominal tergite maculated with three pale pubescent spots, and with a very narrow, apical band of pale pubescence; median spot of the second tergite large, conspicuous, the two lateral spots small, almost obsolete; third abdominal tergite entirely pale pubescent; tergites four and five black pubescent; posterior fifth of pygidium glabrous, unsculptured, the remainder longitudinally striate. Length, 4.5 millimeters.

Head entirely black, except the mandibles medially and the antennal tubercles ferruginous; front and vertex clothed with sparse blackish pubescence, genæ with sparse, pale pubescence; mandibles slender, edentate at the apex, and with a very small obscure tooth within near the apex; clypeus elevated along the transverse, median line, the elevation arcuate; scape with small, sparse punctures and sparse, pale pubescence; first segment of flagellum approximately equal in length to the second; antennal scrobes obscurely carinate above; front and vertex with moderate, dense, somewhat confluent punctures, the genæ with small, dense punctures; relative widths of head and thorax, 2.0: 1.6.

Thorax entirely ferruginous, the dorsum clothed with sparse, erect and suberect, dark fulvous pubescence, the posterior face of propodeum with sparse, long, erect, pale pubescence; humeral angles subangulate; lateral margins of dorsum subparallel, the mesonotal area only very slightly constricted; dorsum with moderate, dense, confluent punctures merging with the reticulations of the propodeum; scutellar scale present and distinct, immediately preceded by an indistinct, transverse groove the width of the thorax; posterior face of propodeum precipitate, almost at right angles to the dorsum, the anterior area reticulate, the posterior area not visible in the type; pleural areas, including sides of propodeum, for the most part glabrous, micropunctate and micropubescent.

Abdomen entirely black; first tergite with sparse, erect, pale pubescence; second tergite with small, dense, confluent punctures, the latter becoming separated and sparse at the sides; clothed with sparse, erect, and short, appressed, black pubescence, except the lateral areas with sparse, erect, pale pubescence, a very narrow, apical band of thick, pale pubescence, and three anterior pale pubescent spots arranged in a transverse line, the median one large and conspicuous, the lateral ones small, almost obsolete; third tergite clothed entirely with sparse, erect and appressed, pale pubescence; fourth and fifth tergites with sparse, black pubescence, except a few pale hairs at the lateral margins; lateral areas of last tergite with sparse, pale fuscous pubescence; posterior fifth of pygidial area glabrous, unsculptured, the remainder longitudinally striate; first sternite with a distinct carina on the anterior two-thirds; second sternite with moderate, distinct punctures, clothed with very sparse, pale pubescence, and with a very thin, apical fringe of pale pubescence; sternites three to five with very small, close punctures towards the posterior margin, and each with a very thin, apical fringe of pale pubescence; hypopygium with very small, close punctures and sparse, pale pubescence.

Legs black, sparsely clothed with pale pubescence; calcaria pale.

*Holotype.*—Female, catalogue No. 49361, United States National Museum, PALAWAN, Puerto Princesa (*Baker*).

*Paratype.*—PALAWAN, female, Puerto Princesa (*Baker*).

Easily recognized by the narrow apical band of the second tergite, and the reduced lateral, pale spots of the same tergite. This may be the female of *palawanensis*.

### SMICROMYRME SEMPERI subsp. SEMPERI (Ashmead).

1904. *Mutilla semperi* ASHMEAD, Proc. U. S. Nat. Mus. 28: 135, male.
1906. *Mutilla semperi* BROWN, Philip. Journ. Sci. 1: 689, male.

*Holotype.*—Male, Manila, in United States National Museum.

The description of the female, heretofore undescribed, is as follows:

*Female.*—Head, abdomen, and legs entirely black, the thorax entirely ferruginous; mesonotal area of thorax slightly but distinctly narrower than the pronotal and propodeal areas; second abdominal tergite with three pale pubescent spots arranged in a transverse row, the median one slightly but distinctly anterior to the lateral ones and in a slightly depressed area; third tergite entirely pale pubescent; pygidial area striate, the striæ not extending to the posterior margin. Length, 4.5 millimeters.

Head black, except the mandibles medially ferruginous; mandibles slender, edentate at the apex and with a very small tooth within near the apex; clypeus elevated along the transverse, median line forming an arcuate carina, the area anterior to the carina glabrous, impunctate; scape with small, sparse punctures and sparse, pale pubescence; first segment of flagellum approximately equal to the second in length; antennal scrobes not carinate above; front, vertex, and genæ with small, dense, more or less confluent punctures, clothed with sparse, pale pubescence, the front also with short, sparse, intermixed, dark pubescence; relative widths of head and thorax, 2.0: 1.6.

Thorax entirely ferruginous, the dorsum clothed with sparse, erect and suberect, dark fulvous pubescence, the posterior face of propodeum with sparse, long, erect pubescence; humeral angles rounded; mesonotal area slightly but distinctly narrower than the pronotal and propodeal areas; dorsum with moderate, dense, confluent punctures; scutellar scale present and distinct, immediately preceded by a transverse groove the width of the thorax; dorsum of propodeum longitudinally rugose, the rugæ irregular in height thus giving the dorsum of propodeum an asperated appearance; pleural areas, including sides of propodeum, finely, closely, shallowly punctate.

Abdomen entirely black; first tergite with sparse, erect, pale pubescence; second tergite with small, dense, confluent punctures becoming separated and sparse at the sides, clothed with sparse, erect and recumbent, black pubescence, except laterally with sparse, erect, pale pubescence, and the three anterior, pale pubescent spots arranged in a transverse row, the median one slightly anterior to the lateral ones and in a slight but distinct depression; third tergite entirely pale pubescent; fourth and fifth tergites black pubescent except laterally with scattered, pale, erect hairs; lateral areas of last tergite with sparse, erect, pale hairs; pygidial area striate, except the posterior fifth glabrous, unsculptured; first sternite with a median, longitudinal carina on the anterior two-thirds, the carina slightly elevated at its posterior terminus; second sternite with moderate, close, distinct punctures, clothed with very sparse, pale pubescence and with a thin, apical fringe of pale hairs; sternites three to six with small, dense punctures at the posterior margin and each with a thin, apical fringe of pale hairs; hypopygium with small, dense punctures and sparse, pale, erect pubescence.

Legs entirely black, sparsely clothed with pale pubescence; calcaria pale.

*Allotype.*—LUZON, female, Los Baños, 1916 (*F. X. Williams*), mounted on the same pin with a male of *semperi* Ashmead and presumably taken in coitu; in the collection of the University of Minnesota.

*Specimens examined.*—LUZON, male, Los Baños, March, 1917 (*F. X. Williams*); 2 males, Los Baños, July, 1916 (*F. Muir*); 2 males, Los Baños, July–August, 1917 (*F. X. Williams*); male, 4 females, Los Baños, August, 1916 (*F. X. Williams*); female, Los Baños, September 23, 1916 (*F. X. Williams*); male, Los Baños, September, 1915 (*F. Muir*); 4 males, 4 females, Los Baños, September, 1917 (*F. X. Williams*); 3 males, female, Los Baños, 1916 (*F. X. Williams*); 24 males, 4 females, Los Baños, 1917 (*F. X. Williams*); female, Los Baños (*F. X. Williams*);

30 males, female, Los Baños (*Baker*); 17 males, female, Mount Maquiling (*Baker*); 2 males, 2 females, Mount Banahao (*Baker*); 2 males, Manila, February, 1919 (*R. C. McGregor*); male, Manila, August, 1923 (*R. C. McGregor*); male, Manila (*Robert Brown*); male, Montalban Gorge, Rizal, March, 1906; female, Montalban (*W. Schultze*); 3 females, Olongapo, Zambales, June 8, 1907 (*C. S. Banks*); 2 males, female, Baguio, June, 1917 (*F. X. Williams*); 4 males, Baguio, Benguet (*Baker*); female, Bangui, Ilocos Norte, June 3, 1913 (*C. S. Banks*); 8 males, female, Malinao, Tayabas (*Baker*). PANAY, male, female, Culasi, June (*R. C. McGregor*); male, northwestern part (*Baker*). NEGROS, 19 males, 3 females, Cuernos Mountains (*Baker*).

The males vary in length from 7 to 11 millimeters, the females from 4 to 6.5 millimeters. The male is easily recognized by the ferruginous first two abdominal segments and the densely punctured tegulæ. The male is related to *hageni* Zavattari from Formosa but differs in having the scutellum sparsely pubescent and in the ferruginous color of the abdomen.

### SMICROMYRME SEMPERI subsp. NIGROGASTRA subsp. nov.

*Male.*—Entirely black, clothed with sparse, erect, pale pubescence, except the front, pronotum, mesopleuræ, transverse band at anterior margin of dorsum of propodeum, and apical bands on first and second abdominal segments, all with dense, appressed, pale pubescence; mandibles excised beneath and with a distinct tooth beneath near the base; clypeus not depressed below the dorsal margin of mandibles; first segment of flagellum about half the length of the second; tegulæ with small, dense punctures and sparse, pale pubescence; second tergite with moderately large, distinct, separated punctures, except the apical margin with very small, close punctures. Wings subfuscous. Length, 10 millimeters.

*Holotype.*—Male, catalogue No. 49362, United States National Museum, LUZON, Zambales Province (*Baker*).

Exactly like the subsp. *semperi* except entirely black. Has much the appearance of *hageni* Zavattari since both are entirely black, but *hageni* has the scutellum thickly clothed with appressed, pale pubescence, while subsp. *nigrogastra* has the scutellum with sparse, erect pubescence.

### SMICROMYRME BAKERI sp. nov.

*Male.*—Entirely black, clothed with sparse, erect, pale pubescence, except the clypeus, front, mesopleuræ, band at anterior margin of dorsum of propodeum, apical bands of first and second abdominal segments, all with thick, appressed, pale pubescence, and last two abdominal segments with sparse, black pubescence; mandibles excised beneath and with a small tooth beneath near the base; first segment of flagellum about one-half the length of the second; tegulæ with small, well-separated, shallow punctures; second abdominal segment with moderate, sparse punctures; posterior inner angle of hind coxæ sharply angulate. Wings subhyaline. Length, 8 millimeters.

Head entirely black, clothed with sparse, erect, pale pubescence except the clypeus and the front with thick, appressed, pale pubescence, and the vertex also with scattered, erect, dark hairs; mandibles excised beneath and with a tooth beneath near the base, edentate at the apex and with a small tooth within near the apex; clypeus not depressed below the dorsal margin of the mandibles, the anterior margin not emarginate, and slightly elevated along the median, longitudinal line; scape bicarinate beneath, with small, dense punctures and sparse, pale pubescence; flagellum as mentioned above; antennal scrobes carinate above; front with small, dense, confluent punctures merging into the longitudinally striate-punctate vertex, and with a median, longitudinal furrow extending anteriorly from the median ocellus; genæ with small, close, distinct punctures; relative widths of head and thorax including the tegulæ, 2.55: 2.9.

Thorax entirely black, clothed with sparse, erect, pale pubescence, except the pronotum with sparse, appressed, pale pubescence, the dorsum of propodeum with a narrow band of dense, appressed, pale pubescence at the anterior margin, and the mesonotum with sparse, suberect, black pubescence; pronotum and mesonotum with moderately small, distinct punctures, well separated on the pronotum, somewhat close on the mesonotum; parapsidal furrows present and distinct; scutellum with moderately small, dense, confluent punctures; dorsum, posterior face, and sides of propodeum rounded into one another, the dorsum and posterior face reticulate; median inclosed space of dorsum of propodeum long, almost three times as long as broad at the base, the sides sinuate, the apex rounded; propleuræ with the anterior margin defined by a carina, very obscurely, obliquely rugose-punctate; mesopleuræ with moderately small, close punctures medially, the anterior and posterior areas almost entirely glabrous, impunctate; metapleuræ glabrous, micropunctate and micropubescent, except for a few, small, shallow punctures ventrally; sides of propodeum reticulate, the reticulations obsolete anteriorly; tegulæ with small, shallow, well-separated punctures, and sparse, pale pubescence throughout.

Abdomen entirely black, clothed with sparse, erect, pale pubescence, except the first and second segments with narrow bands of thick, appressed, pale pubescence, and the last two segments with sparse, erect, black pubescence; first tergite with sparse, moderate punctures becoming close posteriorly and laterally; second tergite with sparse, moderate punctures, the latter closer on the anterolateral areas; tergites three to six with small, sparse punctures; last tergite with small, close, somewhat confluent punctures, sparsely, almost impunctate medially; first sternite with a distinct, median, longitudinal carina on the anterior three-fourths, the posterior terminus of the carina slightly elevated and forming a small tooth; second sternite with moderately small, distinct, well-separated punctures; sternites three to six with small, sparse punctures; hypopygium with small, distinct, close punctures.

Wings subhyaline; cell R + 1st $R_1$ slightly longer than 2d $R_1 + R_2$, the latter acute at the apex; cell $R_5$ receiving vein $M_{3+4}$ at about the middle; cell $R_4$ much less distinct than $R_5$ and receiving vein $M_2$ at two-thirds the distance from base to apex.

Legs entirely black, sparsely clothed with pale pubescence; inner margin of hind coxæ armed with a sharp, prominent carina their full length, the hind margin of the coxæ squarely truncate, thus the posterior inner angle of hind coxæ prominently angulate; calcaria pale.

*Holotype.*—Male, catalogue No. 49363, United States National Museum, PALAWAN, Puerto Princesa (*Baker*).

Very similar in appearance to *semperi* subsp. *nigrogastra* but the tegulæ are much less distinctly punctate, the wings paler, and the body less coarsely punctate.

### SMICROMYRME LAVINIA subsp. LAVINIA sp. et subsp. nov.

*Male.*—Head, thorax, posterior margin of second abdominal tergite, last five abdominal segments, and legs black; first and most of second abdominal segments ferruginous; mandibles excised beneath and with a tooth beneath near the base; clypeus narrowly, distinctly emarginate at the median, anterior margin; first segment of flagellum about half the length of the second; second abdominal tergite with very sparse, small punctures; tegulæ with small, sparse punctures and sparse, pale pubescence; carina of inner margin of hind coxæ not extending to the posterior margin, thus the posterior inner angle of hind coxæ not angulate. Wings subfuscous. Length, 12.5 millimeters.

Head entirely black, clothed with sparse, erect, pale pubescence, except the clypeus, front, and genæ adjacent to posterior eye margins, with thick, appressed, pale pubescence; mandibles excised beneath and with a tooth beneath near the base, edentate at the apex and with a small tooth within near the apex; clypeus almost flat, the anterior margin with a narrow emargination; scape bicarinate beneath, with small, close punctures and sparse, pale pubescence; first segment of flagellum about one-half the length of the second; antennal scrobes not distinctly carinate above; front with moderate, dense, confluent punctures merging into the longitudinally striate-punctate vertex, and with a median, longitudinal furrow extending anteriorly from the median ocellus; genæ with small, distinct, close punctures; relative widths of head and thorax including the tegulæ, 3.9: 4.7.

Thorax entirely black, clothed with sparse, erect, pale pubescence, except the pronotum and dorsum of propodeum with sparse, appressed, pale pubescence, the mesopleuræ with thick, appressed, pale pubescence, and the mesonotum with sparse, erect, dark fuscous pubescence; pronotum and mesonotum with moderate, somewhat confluent punctures; parapsidal furrows distinct on the posterior two-thirds of mesonotum; scutellum with moderate, dense, confluent punctures; dorsum, posterior face, and sides of propodeum all rounded into one another, the dorsum and posterior face reticulate; median, inclosed area of dorsum of propodeum elongate, almost three times as long as broad at the base, the sides sinuate; propleuræ defined anteriorly by a carina, micropunctate and micropubescent, and with a few, shallow, moderate punctures dorsally; mesopleuræ with moderate, close punctures medially, the anterior and posterior areas glabrous, micropunctate and micropubescent, except moderate, shallow punctures ventrally; sides of propodeum reticulate, the reticulations obsolete at the anterior margin; tegulæ with small, sparse punctures and sparse, pale pubescence, the broad outer and posterior margins translucent.

Abdomen black, except the first segment entirely and the second excepting the black posterior margin, both ferruginous, clothed throughout with sparse, erect, pale pubescence, except the last two segments with sparse, erect, black pubescence; first tergite with small punctures, very sparse medially, close laterally and posteriorly; second tergite with small punctures, very sparse medially, closer laterally; tergites three to six with small, sparse punctures; last tergite with moderately small, dense, confluent punctures except a subapical, subtriangular area almost impunctate; first sternite with a distinct carina on the anterior three-fourths, the posterior terminus of the carina slightly elevated; second sternite with moderate, distinct, sparse punctures; sternites three to six with small, close, distinct punctures towards the posterior margin; hypopygium with small, distinct close punctures.

Wings subfuscous; cells R + 1st $R_1$ and 2d $R_1 + R_2$ equal in length, the latter subtruncate at the apex; cell $R_5$ long and narrow, receiving vein $M_{3+4}$ slightly beyond the middle; cell $R_4$ much less distinct than $R_5$ and receiving vein $M_2$ at the middle.

Legs black, sparsely clothed with pale pubescence; carina on inner margin of hind coxæ not extending to the posterior margin, thus the posterior, inner angle not prominent nor angulate; calcaria pale.

*Holotype.*—Male, catalogue No. 49364, United States National Museum, LUZON, Mount Banahao (*Baker*).

*Paratypes.*—LUZON, male, Mount Banahao (*Baker*); male, Mount Maquiling (*Baker*); male, Montalban. MINDANAO, 2 males, Iligan (*Baker*).

The paratypes vary in length from 7.5 to 12.5 millimeters. The paratype from Mount Banahao and the two from Iligan have the first, second, and third tergites entirely ferruginous. The emarginate clypeus, sparsely punctate second abdominal tergite, and only partially carinate hind coxæ will aid in the recognition of this species. It is related to *caecina* Cameron from Borneo.

### SMICROMYRME LAVINIA subsp. ATRATA subsp. nov.

*Male.*—Entirely black, clothed with sparse, erect, pale pubescence, except the clypeus, front, and mesopleuræ with thick appressed, pale pubescence, the pronotum and dorsum of propodeum with sparse, appressed, pale pubescence, and the mesonotum and last two abdominal segments with sparse, black pubescence; mandibles excised beneath and with a tooth beneath near the base; anterior margin of clypeus with a narrow, median emargination; first segment of flagellum about half the length of the second; tegulæ with small, sparse punctures and sparse, pale pubescence, the broad outer and posterior margins translucent; second abdominal tergite with very small, very sparse punctures, becoming closer and slightly larger laterally. Wings subfuscous. Length, 10 millimeters.

*Holotype.*—Male, catalogue No. 49365, United States National Museum, SAMAR (*Baker*).

Exactly like the subsp. *lavinia* except the body entirely black.

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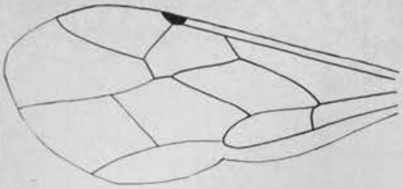
# ILLUSTRATION

## PLATE 1

FIG. 1. *Squamulotilla imparilis* sp. nov., wing.

2. *Squamulotilla teuta* subsp. *teuta* sp. et subsp. nov., wing.
3. *Timulla* (*Trogaspidia*) *minor* subsp. *minor* (Ashmead); uncus, lateral view and dorsal view; squama, lateral view.
4. *Timulla* (*Trogaspidia*) *minor* subsp. *whiteheadi* subsp. nov.; uncus, lateral view and dorsal view; squama, lateral view.
5. *Timulla* (*Trogaspidia*) *minor* subsp. *tayabasensis* subsp. nov.; uncus, lateral view and dorsal view; squama, lateral view.
6. *Timulla* (*Trogaspidia*) *minor* subsp. *visayensis* subsp. nov.; uncus, lateral view and dorsal view; squama, lateral view.
7. *Timulla* (*Trogaspidia*) *minor* subsp. *islandica* subsp. nov.; uncus, lateral view and dorsal view; squama, lateral view.
8. *Timulla* (*Trogaspidia*) *minor* subsp. *princesa* subsp. nov.; uncus, lateral view and dorsal view; squama, lateral view.
9. *Timulla* (*Trogaspidia*) *luzonica* subsp. *luzonica* (Rads.); uncus, lateral view and dorsal view; squama, lateral view.
10. *Timulla* (*Trogaspidia*) *luzonica* subsp. *panayensis* subsp. nov.; uncus, lateral view and dorsal view; squama, lateral view.



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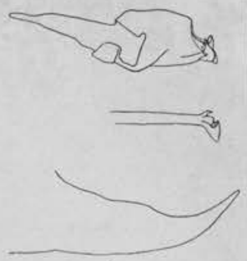

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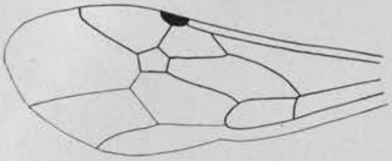

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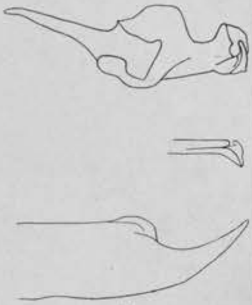

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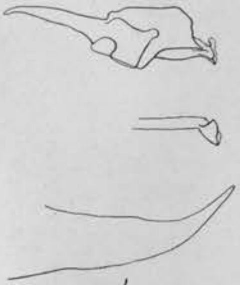

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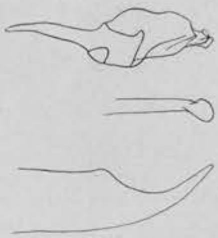

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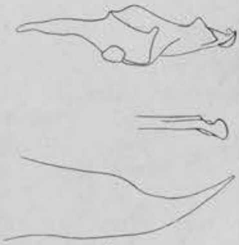

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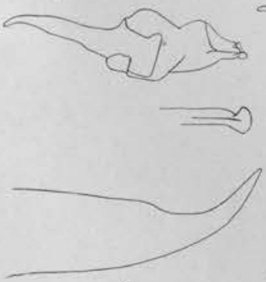

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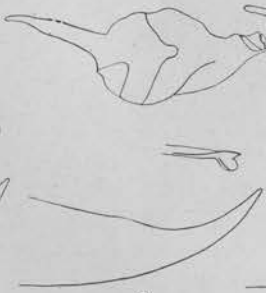

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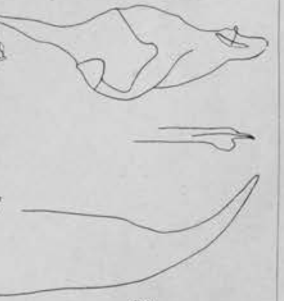

*10*

PLATE 1.